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IDARA (INSTITUTING WATER DEMAND MANAGEMENT IN JORDAN)

Task 1.4- Perform End Use Analysis

Deliverable 2 – End Use Analysis for Large Consumers – Hotels Water Audit Report.

Submitted – November 2011

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IDARA – Water Audits for Large Consumers – Hotel Buildings

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1. Background

Jordan is the fourth (water poorest country on earth. Demand for water already exceeds Jordan's available water resources. Annual per capita water availability has declined from 3600 cubic meters per year in 1946 to around 145 cubic meters per year in 2008. Water demand is currently estimated at around 1530 MCM versus 870 MCM of water resources. The demand is projected to increase to around 1670 MCM by 2022. The high water shortage has caused a drastic over-abstraction of the groundwater aquifers that are pumped at two folds the safe yield. On the other hand, Jordan's stability, tourism attraction, quality of business and health services make it as a prime regional hub for investment. This challenging situation provides a great opportunity for the introduction of the most effective water demand management tools.

Water Demand Management in Jordan started from the bottom of the pyramid concentrating on educating and convincing the public about the need and benefits of water efficiency, then moved up to work with the institutions to develop water demand management policies, institutionalizing WDM; developing standards, codes and regulations; introducing technologies and Best Management Practices. Water Audits are one of the tools and Best Management Practices that determine water use patterns for the various consumer categories, and identify water saving opportunities.

Within the scope of Activity 1, "Institutional Capacity for Water Demand Management", IDARA profiled large Institutional and Commercial (IC) categories in Amman (Figure 1) and recommended five of them for water audits and end use analysis. These IC categories are; health facilities, government office buildings, Schools and Universities, Hotels and Mosques. This report presents water end use analysis for twenty four Hotels that detail the methodology and approach, assumptions, water use evaluation, and conclusions, and recommendations.

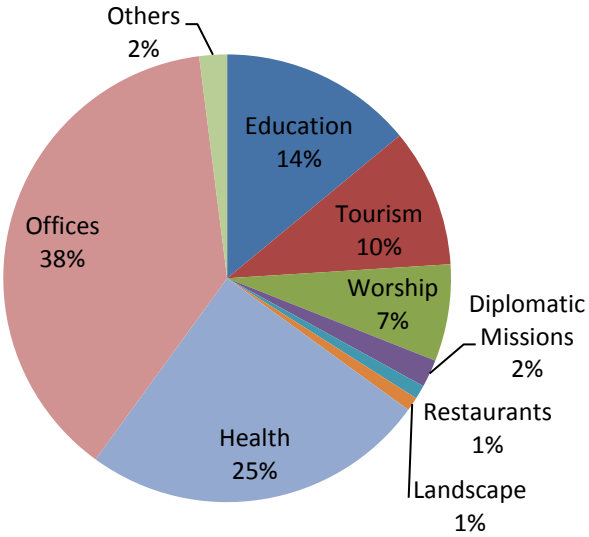

Figure 1: Water Consumption for non-residential users in Miyahuna service area

2. Objective

The main objectives of the end use analysis are summarized below:

1. Establish water use patterns in each of the selected facilities.
2. Determine opportunities to reduce water use.
3. Quantify potential savings as a result of adoption of water use efficiency measures.
4. Establish cost and payback for potential measures.
5. Establish Water Use Baseline to obtain realistic estimates of future water demands.

3. Approach and Methodology

3.1 Overall Methodology

Water uses in hotels generally fall in five categories, plumbing, cleaning, heating, filtration, and outdoor.

The information gathered from the audited Hotels was tabulated and imputed into a "water model" developed by Water Management, Inc. The "model" is a series of excel spreadsheets that are linked together. The calculations for each facility are based on data gathered from the site audits and from engineering calculations. In very broad terms, indoor water use is based on population and flow rates of fixtures and flush volumes of toilets; and irrigation use is based on the surface area being irrigated, the evapotranspiration rate for the area, and type of plants.

Performing an audit of water use for a hotel requires a number of estimates, based on the site visits and the interviews with the staff, below are the steps followed for each of the audits:

1. Complete an initial survey form prior to the site visit (See Appendix A for a copy of the audit form).
2. Conduct site visit interviews with the staff to confirm the information in the survey form and to obtain additional data on levels of activity in individual departments,
3. Collect water use information from water bills and other water sources (wells, harvesting, water tank trucks) data, if any.
4. Make flow measurements and set assumptions during the site visit.
5. Follow-up questions after the site visit.
6. Input data gathered including water use information and fixture counts into the water model
7. Establish end use water balance, potential savings and related cost benefits.

3.2 Data Collection

Water Use Data

Gathering potable water use data starts with identifying and recording all water sources such as metered supplies from water utilities, water supplied by wells and similar self supplies sources, and tank truck deliveries. These data were collected as part of the initial survey form sent prior to the visit and were confirmed or modified at the time of the site visit based on information provided at that time. Usage profile for the sanitary fixtures is primarily based on two parameters, which are; population and the frequency of use of these fixtures. The population includes guests, staff and visitors.

Flow Measurement Collection

Domestic Fixtures: During the walkthrough, representative samples of faucets, trigger sprays, and bidets were chosen for measurement. The "Bucket and Stop Watch" method was used to gather this data. Faucet and showerhead flow rates were measured using a calibrated flow bag. Faucets flow rates were taken by turning the valve a quarter turn, the auditor collects water for five seconds and then notes the water level in the bag which corresponds to the calibration on the bag in liters per minute (lpm).

Some of the toilet fixtures in the audited hotels are "Turkish" style, which means they have no tank, flush valve, or button-actuated water delivery system. Instead, users must fill a small bucket (usually 2 liters in volume) and manually clear waste from the floor basin and drain. This water is also used for personal hygiene in place of toilet paper. As such, there is no pre-set "flush volume" related to these fixtures. In order to calculate the water consumed in toilet "flushing" the following information was required: quantity of water required for clearing solid and liquid waste, whether the user would "flush" the toilet after every use, and how much water is used to wash the basin after evacuation. The measurement of water use in toilets was done either by using a T-5 measuring device that measures actual volume of water flushed or by examining the tank size and observing the actual flush. Where tanks were not accessible or flush valves were used, the volume was estimated based on the make and model of the toilet. Again, a representative sampling of toilets was measured.

Irrigation: - The irrigation water use estimation was based on local evapotranspiration and rainfall data, vegetation type (shrubs, grass, and trees) and planted area.

Cleaning: A conservative standard is proposed to calculate cleaning water in the audited facilities. Cleaning water was estimated at 0.125 liters per square meter per week. For Turkish toilet cleaning the same number was assumed in daily basis, and for gravity type toilets two flushes per day were allotted for cleaning.

3.3 Auditing Equipment

Following are the auditing equipment used to conduct indoor water use audits:

1. Graduated Cylinder
2. Portable timing device
3. Tape Measure
4. T-5 device to measure flush volumes
5. Other equipment as needed

Figure 2: Flow bag used for measurement

Figure 3: T-5 device to Measure the Toilet Flush Volume.

Figure 5: Graduated Cylinder

Figure 4: Ultrasonic flow meter

4. Assumptions

The following assumptions were developed to calculate the water balance:

Apartment Hotels

- A staff member/worker will use the public or staff restroom once every four hours (2 times in an 8 hour shift).
- A hotel guest will use the restroom in their room once every 4 hours (3 times in 12 hours a day).
- A visitor to the hotel will use the guest room toilet once every 2 hours. The assumed length of visit for each visitor is 2 hours. Therefore, on average, every visitor will use the restroom once during their visit.
- It is assumed that the public or staff toilets are evacuated in some manner 90% of the time it is used by staff. 10% of users will void and leave without flushing. This flush rate improves to 95% for guest toilets.
- It is assumed that 40% of staff, guests, and visitors using the toilet will use the bidet or an accompanying hose for 12 seconds per use. Apartment hotels have a mixture of bidet fixtures and trigger hoses; flow rates associated with hoses and bidet fixtures average 6.7lpm and are hotel specific.
- 100% of all guests will use the lavatory faucet in the guest room for 6 minutes daily. This figure attempts to include use for brushing teeth, hand-washing, ablution, cosmetic application, shaving, etc. For staff and visitors, this use is calculated at 6 seconds per toilet use.
- It is assumed that 85% of guests will shower for 8 minutes per day.
- Bathroom cleaning water consumption for guest rooms is assumed at 2 tank toilet flushes per occupied room daily. This figure represents all water used to clean bathroom fixtures and counter/floor surfaces. All non-bathroom related cleaning water is assumed at 0.125 liters per non-carpeted square meter twice weekly. Non-carpeted meters are estimated by WMI based on total building square meters.

All Other Hotels

- A staff member/worker will use the public or staff restroom once every 2 hours (4 times in an 8 hour shift).
- A hotel guest will use the restroom in their room once every two hours.
- A visitor to a hotel will use the guest room toilet once every 2 hours. The assumed length of visit for each visitor is 2 hours. Therefore, on average, every visitor will use the restroom once during their visit.
- It is assumed that the public or staff toilets are evacuated in some manner 90% of the time it is used by staff. 10% of users will void and leave without flushing. This flush rate improves to 95% for guest toilets.
- It is assumed that 40% of staff, guests, and visitors using the toilet will use the bidet or an accompanying hose for 12 seconds per use. Hotels have a mixture of bidet fixtures and trigger hoses; flow rates associated with hoses and bidet fixtures are hotel specific.
- 100% of all guests will use the lavatory faucet in the guest room for 6 minutes daily. This figure attempts to include use for brushing teeth, hand-washing, ablution, cosmetic application, shaving, etc. For staff and visitors, this use is calculated at 6 seconds per toilet use.
- It is assumed that 85% of guests will shower for 10-12 minutes per day. This figure increases for hotels to account for an increase in Western clientele.
- Bathroom cleaning water for guest rooms is assumed at 2 tank toilet flushes per occupied room daily. This figure represents all water used to clean bathroom fixtures and counter/floor surfaces. All non-bathrooms related cleaning water is assumed at 0.125 liters per non-carpeted square meter twice weekly. Non-carpeted meters are estimated based on total building square meters.
- Commercial kitchen usage per meal is estimated at 15-20 liters per meal served.
- Laundry usage is estimated at 20 liters per kilogram of cloths. This estimate is very conservative, as several studies place average laundry use per kilogram at 22L/kg.
- Assumptions regarding pool, softener/RO/filter, and water feature use are site specific and based on information obtained from staff.
- Ice machines produce 5.4 liters of ice per guest per day.

5. Water Use Evaluation

5.1 Audited Facilities

Apartment Hotels

Facility 1

Background

Facility 1 was built in 1995. New ownership recently remodeled significant portions of the hotel and informed the audit team that a complete retrofit of the existing plumbing fixtures is planned. The hotel has 5 staff members for 29 apartments (8 two bedroom units, 18 one bedroom units, and 3 studio units). Occupancy is estimated at 40% annually, with an average of 2.5 people staying in an occupied room for approximately 14 hours per day.

Water Balance and End Use Types

The facility receives water (Fri/Sat.) and sewer service from Miyahuna and does not receive supplementary tanker water. After performing an end-use analysis of the facility, 1,980 m3 of consumption yearly was estimated.

The hotel has no central steam boiler, no cooling tower, no kitchen, no irrigation, and no laundry operation. The facility has a total water storage capacity between 35m3-45m3. Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 4th floor and gravity-fed throughout the building. None of the water entering the hotel is treated.

Water use at this facility is limited to toilets, bidets, showers, and lavatory and kitchen faucets. The units that were observed with 2 bedrooms had 2 bathrooms; those with 1 bedroom had a single bathroom. The hotel owner that accompanied the audit team during the audit was knowledgeable and proactive regarding maintenance.

Domestic fixtures appeared in good overall condition. The toilet fixtures observed were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had a flush tower mechanism that dispensed an average of 8.9 lpf. The owner expressed dissatisfaction with this overall flow rate and cited fixture flow rates as a driving force behind the planned facility retrofit. Bidet trigger hose usage averaged 7.6 lpm, similar to flow rates observed at other apartment hotels.

It was estimated that a majority of the water use at the facility occurs in the shower, the second largest usage category. The average shower flow rate was 7 lpm and this too was similar to other apartment hotels. There is no recommendation for a shower-related retrofit at this time, though the hotel should consider upgrading its equipment. The low flow rate is not due to the showerhead itself, but rather the low building pressure. Variations in pressure between the cold and hot water systems can incrementally affect showerhead flow rates, which can substantially increase consumption over time. An increase in pressure on the hot water line resulting in a liter increase in shower flow, from 7 liters to 8 liters, would cause an additional usage of 59 m3 per

year. Pressure-compensating showerheads will eliminate concerns related to pressure differential and standardize flow rates. Maximum recommended flow rates for this application are 7.6 lpm; however it is not recommend exceeding the existing 7 lpm if customers are currently satisfied with fixture efficiency.

Hotel lavatory faucets possessed the lowest flow rates among apartment hotels at 4.2 lpm. This low flow is attributed to faucet flow controls, though none were pressure-compensating. Lavatory flow rates measured on the top floors were 3.8 lpm, while the one measured on the lower floor (2nd) was 5 lpm. The building pressure on the 2nd floor was measured to be 1.38 bars. Kitchen lavatories had significantly higher flow rates, averaging 12.8 lpm. The lowest unit audited possessed an 8 lpm flow rate, the highest was 19 lpm. Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms, equaling 102m3 annually. Water used to clean non-bathroom surfaces is estimated at 20m3 per year based on the assumptions for non-bathroom surfaces.

The results of the end use water balance are illustrated in the Table below.

Table 1: End Uses of water at facility 1

Types	**Avg %**	**m³/year**
Toilets	34%	666
Urinals & Bidets	11%	215
Faucets	30%	590
Showers	22%	442
Cleaning	3%	67
Total		**1,980**

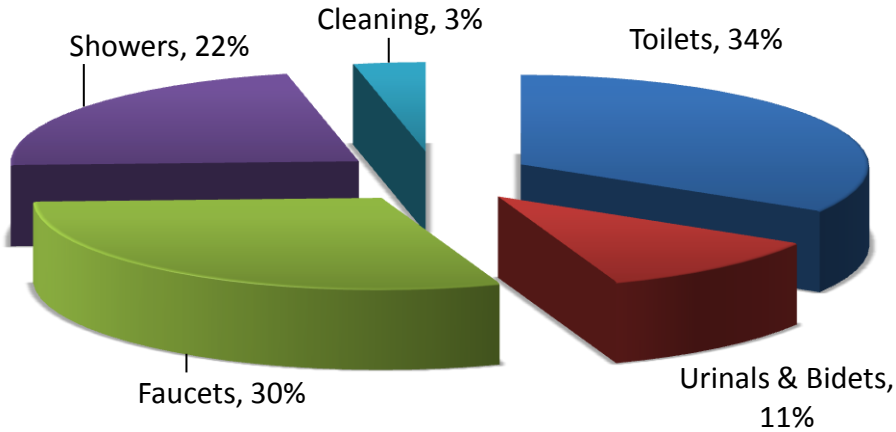

Figure 6: Water use percentages at facility1

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Kitchen Faucets

It is recommended to retrofit kitchen faucets at the facility with pressure-compensating flow controls. While comprising less overall usage than the lavatories, reducing flow rates on kitchen faucets will yield greater savings if usage assumptions are feasible.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m3/year (Pre Program)	
Toilet consumption per year	666
Bidet consumption per year	215
Lavatory consumption per year	29
Shower consumption per year	441
Kitchen faucet consumption per year	560
TOTAL DOMESTIC CONSUMPTION	1,911

Building Domestic Subtotals - Consumption m3/year (Post-Program)	
Toilet consumption per year	299
Bidet consumption per year	28
Lavatory consumption per year	29
Shower consumption per year	480
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	1,199

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 713 m^3 per year, which is equivalent to an annual saving of 36% of the total water use.

Facility 2

Background:

This Apartment Hotel is a 6,750 m^2 facility built in 2006. The hotel has 6 employees serving 30 rooms. Occupancy is estimated at 50% annually, with an average of 2.25 people staying in an occupied room for approximately 14 hours per day.

Water Balance and End Uses:

This Apartment Hotel receives water 2 days weekly and sewer service from Miyahuna. The facility annual water use was estimated at 3,234 m^3. The audit of the hotel provided an opportunity to obtain a larger than typical sample of fixture flow rates.

The hotel has no central steam boiler, no cooling tower, no main kitchen, no irrigation, and no laundry operation. The building has 50 m^3 of water storage on the ground, which is pumped to storage tanks on the roof and gravity-fed to guest rooms on 5 floors. None of the water entering the hotel is treated.

The non-plumbing use of water in the hotel is portable LG WP-780NP clothes washing machines located in each room. These units are manually filled with water, so actual consumption per cycle depends on the individual user. Usage for the LG units was calculated at two loads of clothes weekly per occupied room at the maximum per cycle consumption (42 liters). No recommendation for retrofit is proposed for these units. Aside from these clothes washers, water use at this building is limited to toilets, bidets, showers, and lavatory and kitchen faucets.

Figure 7: Dual tub clothes washer

Domestic fixtures appeared in above average condition, likely due to the facility's young age. The audit team calculated separate flow rates for staff flushes, assuming employees used the two public restrooms in the building lobby. The toilet fixtures observed were tank and bowl and most rooms had an accompanying china bidet fixture. Guest toilets observed had ball float valve mechanisms that dispensed an average of 7.4 lpf, the second lowest toilet flush rate among apartment hotels. The audit team dye tested two toilet tanks for leaks finding neither inefficient. Rooms either had a china bidet fixture or trigger spray accompanying each toilet. Bidet flow rates averaged 6.1 lpm.

The average shower flow rate was 5.7 lpm, by far the lowest flow rate observed in the apartment hotel sector. Again, the team is confident these low flow rates were not due to the efficiency of the showerhead, rather the lack of system pressure delivering water to the fixture.

Hotel lavatory faucets possessed an average flow rate of 5.8 lpm, a reasonable flow rate compared to other apartment hotel sites. Still, installing 4.5 lpm flow controls should reduce lavatory consumption further, without sacrificing guest satisfaction. Kitchen lavatories

averaged 7.6 lpm. Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms. The results of the end use water balance are illustrated in the Table below.

Table 2: End uses of water at facility 2

Types	Avg. %	m^3/year
Toilets	32%	1,048
Bidets	10%	329
Faucets (Kit and Lav)	14%	466
Showers	35%	1,132
Cleaning	3%	105
Laundry	4%	131
Others	1%	23
Total		**3,234**

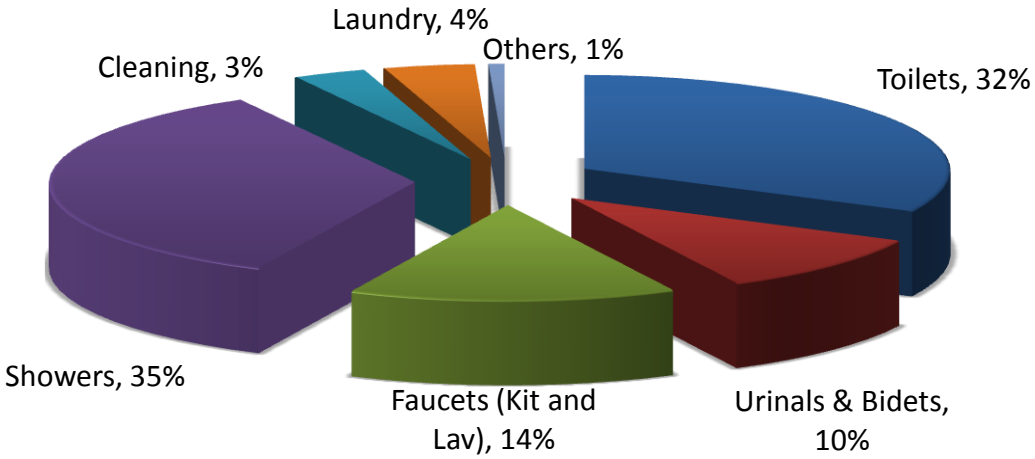

Figure 8: Water use percentages at facility 2

Recommended Measures

Toilets

Toilet tanks should be retrofitted with 6 lpf volume flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory Faucets

Lavatory faucet flows at this facility are relatively low compared to other apartment hotel facilities. However, the hotel could achieve considerable savings by installing compensating 4.5 lpm flow faucet aerators.

Potential Domestic Savings

Building Domestic Subtotals - Consumption (Pre Program) m3/year	
Toilet consumption per year	1,048
Bidet consumption per year	329
Lavatory consumption per year	133
Shower consumption per year	1,132
Kitchen faucet consumption per year	333
TOTAL DOMESTIC CONSUMPTION	2,975

Building Domestic Subtotals - Consumption (Post-Program)	
Toilet consumption per year	568
Bidet consumption per year	328
Lavatory consumption per year	103
Shower consumption per year	1,131
Kitchen faucet consumption per year	332
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	2,462

According to the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 513 m^3 per year, which is equivalent to an annual saving of 16% of the total water use.

Facility 3

Background:

The 1,650 m^2 Hotel was built in 1993. The hotel has 4 staff members for 20 rooms (12 two bedroom units and 8 one bedroom units). Occupancy is estimated at 55% annually, with an average of 1.75 people staying in an occupied room for approximately 14 hours per day. Based on information provided by the hotel manager, less than two persons per room at this apartment hotel were assumed as many guests are single occupants (workers, people in Amman for outpatient medical treatment, etc).

Water Balance and End Use Types:

This facility receives water 2 days weekly and sewer service from Miyahuna. The hotel manager informed the audit team they receive 20 m^3 tanker water once or twice weekly during the three peak summer months. 30 m^3 for 10 weeks were assumed, totaling 300 m^3 of tanker water annually. The hotel used 1,161m^3 of city water between Q2-2007 and Q2-2008. Combining estimated tanker usage with Miyahuna water equals an annual consumption of 1,461m^3.

Figure 9: Visible leaks at Facility 3

The hotel has no central steam boiler, no cooling tower, no kitchen, no irrigation, and no laundry operation. The hotel has a total water storage capacity of 45 m^3 (24 m^3 of ground storage, 21 m^3 of rooftop storage). Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 4th floor and gravity-fed throughout the building. The Audit team noted some leakage surrounding the ground storage tanks and an improperly installed water meter. Both of these instances are negatively impacting the baseline water usage. The improperly installed meter is likely under recording facility usage, while the storage tank leak is wasting water before it reaches the end user. None of the water entering the hotel is treated.

Figure 10: Plumbing fixtures at facility 3

Domestic fixtures appeared in average condition. The toilet fixtures observed were tank and bowl and most rooms had an accompanying bidet fixture. Toilets observed had a flush tower mechanism that dispensed an average of 8.3 lpf. The bidets sprayed directly up at the end user with no hose or nozzle making flow measurement difficult.

The average shower flow rate was 10.5 lpm, the highest flow rate observed in the apartment hotel sector. While this average flow rate is not excessively over the maximum recommended shower flow rate of 7.6 lpm, the team did measure other units using in excess of 12 lpm. The team measured a building pressure of 1.38 bars on the 2nd floor and showerhead flow rates on this lower floor were higher than those recorded on the 4th floor (+3 lpm). The team recommends these showerheads be replaced with pressure-compensating units that operate at a maximum flow rate of 7.6 lpm.

Figure 11: Utility water meter at facility 3

Hotel lavatory faucets possessed an average flow rate of 7.8 lpm. Installing 4.5 lpm flow controls would cut lavatory faucet consumption at facility by more than 40%. Kitchen lavatories averaged 10 lpm. A unit measured on the 4th floor with a flow restrictor used 7 lpm, while a unit on the 2nd floor possessing only a strainer used 12 lpm. According to these measurements, installing a 8.3 lpm pressure-compensating flow restriction device in the kitchen faucets could save approximately 36 m^3 (56JD+hot water energy) annually. Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms.

The results of the end use water balance are illustrated in the Table below.

Table 3: End uses of water at facility 3

Types	Avg. %	m^3/year
Toilets	26%	377
Bidets	5%	69
Faucets (Kit and Lav)	32%	472
Showers	30%	437
Cleaning	2%	38
Ice Machines	1%	8
Others	4%	60
Total		**1,461**

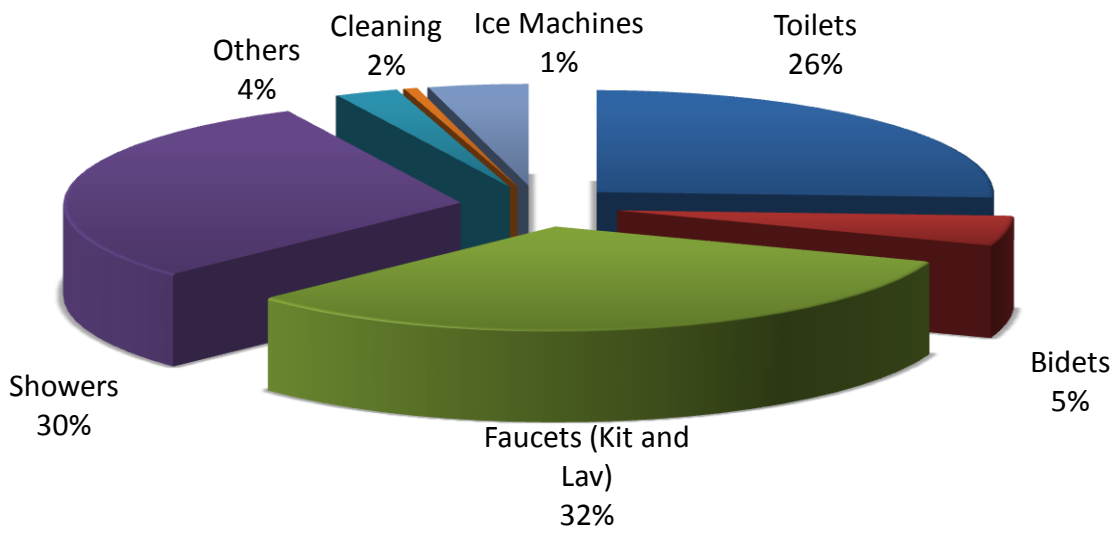

Figure 12: Water use percentages at Facility 3

Recommended Measures:

While the team did not observe "running water" from the storage tanks at this apartment hotel, it did observe standing water around and beneath the tanks and some algae/plant growth in those puddles, this indicates a constant leak. This is wasted water and money. The Hotel needs to thoroughly inspect each of its twelve $2m^3$ storage tanks for leaks and repair or replace them. Two meters were noted where water service enters the property, however it is unknown which Miyahuna is using to bill the hotel. One of the meters is installed at an angle and it is likely not functioning properly. Typically, improperly installed meters allow non-revenue water to pass through to the customer without registering on the meter. Therefore, it is certainly in the interest of the utility to visit the property and make sure its equipment is functioning properly.

Toilets

Toilet tanks should be retrofitted with 6 lpf that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory & Kitchen Faucets

The hotel should consider retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, and kitchen faucets should be retrofitted with 8.3 lpm faucet aerators.

Showerheads

The showerheads in the guest rooms operate at an average flow rate of 10.5 lpm. As discussed above, retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption at least 28%. This figure is likely low as those showerheads on the bottom floors with greater water pressure are consuming more than 10.5 lpm. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m3/year (Pre Program)	
Toilet consumption per year	377
Bidet consumption per year	69
Lavatory consumption per year	33
Shower consumption per year	436
Kitchen faucet consumption per year	438
TOTAL DOMESTIC CONSUMPTION	1,353

Building Domestic Subtotals - Consumption (Post-Program)	
Toilet consumption per year	181
Bidet consumption per year	17
Lavatory consumption per year	19
Shower consumption per year	331
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	911

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 442 m^3 per year, which is equivalent to an annual saving of 30% of the total water use.

Facility 4

Background:

Constructed in 1999, this Apartment Hotel is a 5 floor facility located near the Jordan University Hospital. The hotel has 8 employees serving 30 rooms. Occupancy is estimated at 30% annually, with an average of 2.25 people staying in an occupied room for approximately 14 hours per day.

Water Balance and End Use Types:

The Hotel receives water and sewer service from Miyahuna. After performing an end-use analysis of the facility, an annual usage of 1,813 m^3 was estimated. The remaining 1% of the hotel's unaccounted usage is attributed to system inefficiency (leaks) or discrepancies in information regarding hotel occupancy (population). The occupancy rate provided by the hotel is approximately 25% lower than similar hotels in this sector. The hotel has no central steam boiler, no cooling tower, no kitchen, no irrigation, and no laundry operation. None of the water entering the hotel is treated.

Domestic fixtures appeared in average condition. The toilet fixtures observed were tank and bowl and most rooms had an accompanying china bidet fixture. Guest toilets observed had ball float valve mechanisms that dispensed an average of 7.0 lpf, the lowest toilet flush rate among apartment hotels. However, one of the units (Rm. 301) audited failed a dye leak test, so the hotel should conduct in-house periodic leak detection audits to repair leaks and reduce waste.

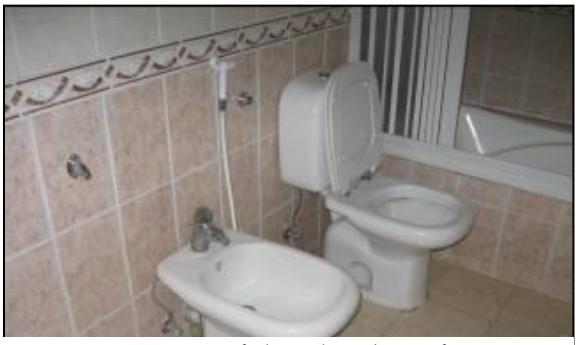

Figure 13: Some of the plumbing fixtures at facility no. 4.

Bidet flow rates averaged 8 lpm, the highest average flow rate in this IC sector. It is recommended to retrofit the bidet fixtures/trigger hoses with 4.5 lpm pressure-compensating flow restrictors.

The average shower flow rate was 7 lpm. While recommends retrofitting the showerheads to standardize fixture flow rates and ensure pressure changes will not affect fixture consumption, but for the time being such a retrofit is not necessary as none of the measured showerheads approached 7.6 lpm.

Hotel lavatory faucets possessed an average flow rate of 7.6 lpm. Installing 4.5 lpm flow controls should reduce lavatory consumption, without sacrificing guest satisfaction. Lavatories flow in public area restrooms were 15 lpm. While these likely receive less usage than guest lavatories, retrofitting these faucets with flow restrictors will easily cut consumption. Kitchen lavatories averaged 8.4 lpm in guest rooms and 11.4 lpm in staff areas. Retrofitting kitchen faucets with 8.3 lpm maximum flow controls will yield the least savings of all possible domestic measures because of the low existing flow rate and fixture consumption profile. Two flushes per fixture for bathroom cleaning is allotted in occupied guest rooms.

The results of the end use water balance are illustrated in the Table below.

Table 4: End uses of water at facility 4

Types	Avg. %	m³/year
Toilets	29%	531
Urinals & Bidets	13%	229
Faucets (Kit and Lav)	34%	612
Showers	20%	368
Cleaning	3%	53
Others	1%	20
Total		1,813

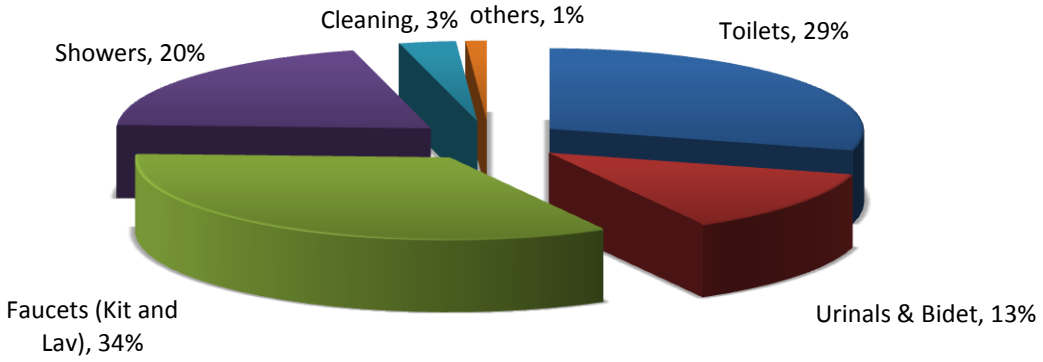

Figure 14: Water use percentages at Facility 4

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6 lpf that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory & Kitchen Faucets

Lavatory faucet flows at the building are much higher than necessary for hand washing and hygiene purposes. The hotel could achieve considerable savings of both water and energy by installing compensating 4.5 lpm flow controls – halving the average existing flow rate. Kitchen faucets are inefficient in the staff area, these kitchen faucets should be retrofitted with pressure-compensating flow controls that use 6 lpm or less.

POTENTIAL DOMESTIC SAVINGS:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	531
Bidet consumption per year	229
Lavatory consumption per year	122
Shower consumption per year	368
Kitchen faucet consumption per year	490
TOTAL DOMESTIC CONSUMPTION	1,740
Building Domestic Subtotals – Consumption m^3/year (Post-Program)	
Toilet consumption per year	303
Bidet consumption per year	28
Lavatory consumption per year	64
Shower consumption per year	401
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	1,159

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 581 m^3 per year, which is equivalent to an annual saving of 32% of total water use.

Facility 5

Background:

The Hotel was constructed in the early 1960's. Plumbing fixtures were renovated approximately 5 years ago. Occupancy is estimated at 45% annually, with an average of 2 people staying in an occupied room for approximately 12 hours per day. While other apartment hotels have average occupied room populations over 2 persons, because the hotel guests are mostly tourists two guest per occupied room was estimated. While the owner of the hotel provided a slightly lower figure (1.5 guests per room), calculating 2 guests brings the excessive consumption of the hotel into better contrast.

Water Balance and End Use Types:

The building receives water (3 days weekly) and sewer service from Miyahuna. The annual water consumption of the hotel was estimated at 2,557 m^3.

The hotel has no central steam boiler, no cooling tower, no kitchen, no irrigation, and no laundry operation. Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 5th floor and gravity-fed throughout the building. None of the water entering the hotel is treated. Since this hotel is not a true apartment-style hotel, there are no kitchen faucets. Each room has only a lavatory faucet.

Figure 15: flushing device at facility no. 5

Domestic fixtures appeared in average condition. The toilets were the most inefficient fixture set surveyed in this sector. The individual fixture flow rates were between 7-10lpf, however the need to hold down the handle on many units made the likely volume of water delivered for each flush higher. The toilet fixtures observed were tank and bowl and most rooms had an accompanying bidet fixture. Toilets observed had flush tower mechanisms with vertical floats and ball floats that dispensed an average of 10 lpf. The toilet flush volumes were difficult to measure because many units would not actuate sufficiently by simply depressing the tank handle. To achieve a quality flush, the user must hold the handle down at which point the flush tower mechanism remained in the open position until the tank was nearly emptied. This transformed an 8-9 lpf toilet into a 10+lpf fixture. The average shower flow rate was 6.5 lpm, likely due to low building pressure. The showerheads did have flow restriction devices in them, which may contribute to the fixtures using a relatively low amount of water. However, shower pressures were weak overall and flow rates varied between floors (5-8 lpm), suggesting that the flow restrictors are not primarily responsible for limiting flows. While it is not recommended to retrofit the showerheads to standardize fixture flow rates and ensure pressure changes will not affect fixture consumption, it does not believe such a retrofit is necessary at this time as none of the measured showerheads approached 7.6 lpm. Hotel lavatory faucets possessed an average flow rate of 10.7 lpm. Installing 4.5 lpm flow controls would cut lavatory faucet consumption at the facility by approximately 58%. By far, the hotel had the highest lavatory flow rates in this sector.

The faucets had strainers, but no flow controls resulting in sieve-like flow rates. Building pressure generated slight increases in faucet flow rates on ground floors (from 10.5 lpm to 11 lpm), but the high flow rates cannot be attributed to some faucets on lower floors.

Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms, equaling 102 m^3 annually. Water used to clean non-bathroom surfaces is estimated at 20m^3 per year based on the assumptions for non-bathroom surfaces.

The results of the end use water balance are illustrated in the Table below.

Table 5: End uses of water at facility 5

Types	**Avg. %**	**m^3/year**
Toilets	51%	1,306
Urinals & Bidets	15%	386
Faucets (Kit and Lav)	10%	256
Showers	19%	478
Cleaning	5%	131
Total		**2,557**

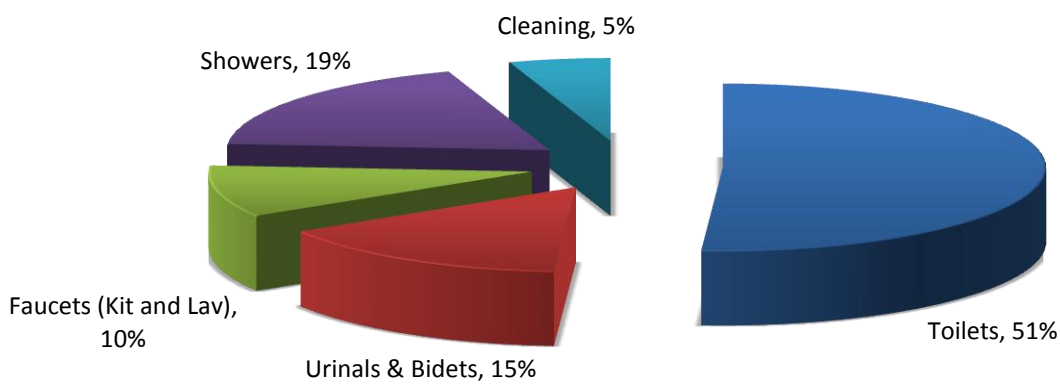

Figure 16: Water use percentages at facility 5

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6 lpf that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory Faucets

Lavatory faucet should be retrofitted with pressure-compensating 4.5 lpm flow controls. This could save approximately 12-15% of total facility use.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,306
Bidet consumption per year	386
Lavatory consumption per year	256
Shower consumption per year	478
TOTAL DOMESTIC CONSUMPTION (L/yr)	2,426

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	522
Bidet consumption per year	68
Lavatory consumption per year	107
Shower consumption per year	478
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM (L/yr)	1,175

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 1,251 m^3 per year which is equivalent to an annual saving of 49% of total water use.

(2-3) Star Hotels

Facility 6

Background:

The Hotel is an approximately 7,000 m^2 was built in 1977. The hotel has 23 staff members for 100 rooms. Occupancy is estimated at 40% annually, with an average of 1.25 people staying in an occupied room for approximately 12 hours per day.

Water Balance and End Use Types:

The facility receives water and sewer service from Miyahuna and does not receive supplementary tanker water. According to Miyahuna, the hotel used 3,474 m^3 between Q3-2007 and Q3-2008. The hotel has no central steam boiler, no cooling tower, and no laundry operation. The hotel does have a small area of turf irrigated with a hose twice weekly. The site was unable to provide the number of square meters irrigated, so this usage has been estimated at 20m^3 annually based on information obtained during the audit. The hotel also has a commercial kitchen which prepares approximately 45 meals a day. The kitchen uses water in steam kettles for food preparation and makes ice in a small ice machine with an air-cooled condenser. The commercial dish washer is not utilized, instead employees hand wash dishes. This practice often leads to faucets running long periods of time to elevate wash basins to temperature, rinse dishes prior to the wash phase, or multiple evacuations of the wash basin throughout the day.

Domestic fixtures appeared in average overall condition. The toilet fixtures observed by the audit team were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had a flush tower mechanism that dispensed an average of 9.0 lpf. The hotel can reduce its flow rate per fixture approximately 33% by retrofitting the existing units to 6 lpf. Bidet trigger hose usage averaged 6 lpm, similar to flow rates observed at other hotels.

It was estimated that the largest domestic water use at the hotel was in the toilets. The average shower flow rate was 7.6 lpm, equaling the recommended maximum flow rate. There is no recommendation for a shower-related retrofit, though the hotel should consider upgrading its equipment. The low flow rate is not necessarily due to the showerhead itself, but also low building pressure. Variations in pressure between the cold and hot water systems can incrementally affect showerhead flow rates, which can substantially increase consumption over time. Furthermore, higher pressures on lower floors can generate consumption increases at fixtures closer to the ground floor. Pressure-compensating showerheads will eliminate concerns related to pressure differential and standardize flow rates.

Hotel lavatory faucets were measured operating at 5.5 lpm. This relatively low flow is attributed to faucet flow controls, though none were pressure-compensating. Water is gravity-fed from rooftop tanks, ensuring that without pressure regulating valves, water pressure will be higher on lower floors resulting in greater consumption at those fixtures. The audit team measured building pressure on the 1st floor at 2.62 bars. Kitchen faucets had significantly higher flow rates, averaging 9 lpm. It is recommended to reduce these faucets to 8.3 lpm if kitchen activities allow.

Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms. .

Table 6: End uses of water at facility 6

Types	Avg. %	m³/year
Toilets	36%	1,261
Urinals & Bidets	9%	316
Faucets (Kit and Lav)	15%	519
Showers	29%	999
Cleaning	6%	195
Com. Kitchen (Food services)	5%	164
Landscape	0.5%	20
Total		**3,474**

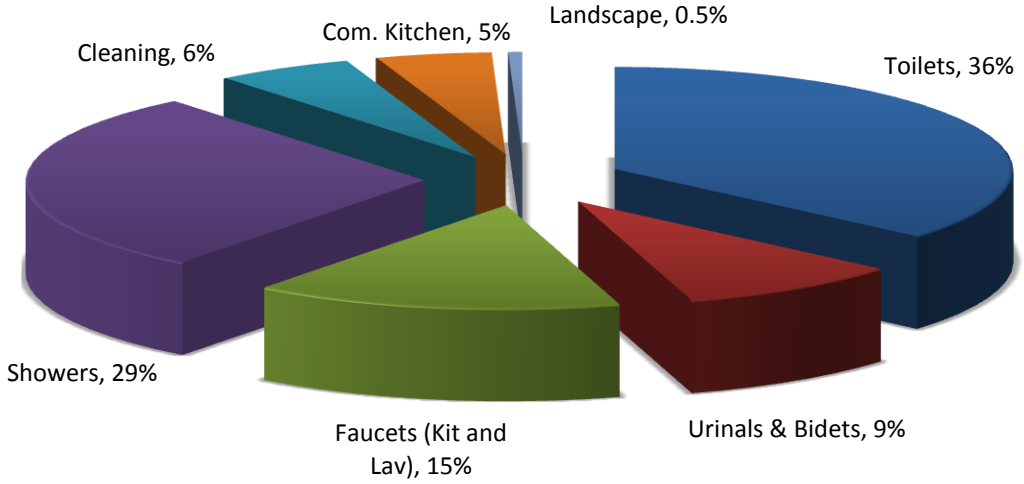

Figure 17: Water use percentages at facility 6

Recommended Measures

Toilets

Toilet tanks should be retrofitted with 6lpf that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory & Kitchen Faucets

Faucet flow rates are quite reasonable when compared to both industry standard and exceptional compared to most Jordanian facilities. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 193 m^3 annually and additional energy costs associated with hot water production and boiler operation.

Reducing kitchen faucet flows may not reduce kitchen consumption as often times faucet use is related to activities such as basin filling for dish washing and meat thawing. For tasks where a finite amount of water is necessary, reducing flows may only lengthen the time needed to complete the action.

Proposed Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,261
Bidet consumption per year	316
Lavatory consumption per year	125
Shower consumption per year	999
Kitchen faucet consumption per year	394
TOTAL DOMESTIC CONSUMPTION	3,095

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	560
Bidet consumption per year	315
Lavatory consumption per year	101
Shower consumption per year	999
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	2,338

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 762 m^3 per year, which is equivalent to an annual saving of around 22 % of total water use.

Facility 7

Background:

The Hotel was built in 1978. The hotel has 65 staff members for 96 rooms. Occupancy is estimated at 80% annually, with an average of 1.72 people staying in an occupied room for approximately 12 hours per day.

Water Balance and End Use Types:

The hotel receives water and sewer service from Miyahuna exclusively. The facility annual consumption was estimated at 5,441 m^3.

The toilet fixtures observed were tank and bowl and most rooms had an accompanying china bidet fixture. Toilets observed had a flush tower mechanism that dispensed an average of 8.0 lpf.. The hotel can reduce its flow rate per fixture approximately 25% by retrofitting the existing units to 6 lpf, even more by installing dual-flush tanks. Bidet trigger hose usage averaged 6 lpm, similar to flow rates observed at other hotels.

The hotel has no central steam boiler, no cooling tower, and no laundry operation. The hotel does have a small area of turf irrigated with a hose twice weekly. This usage has been estimated at 20m^3 annually. The hotel also has a commercial kitchen which prepares approximately 180 meals a day. The kitchen uses water in steam kettles for food preparation and makes ice in a small ice machine with an air-cooled condenser. The commercial dish washer is not utilized, instead employees hand wash dishes. This practice often leads to faucets running long periods of time to elevate wash basins to temperature, rinse dishes prior to the wash phase, or multiple evacuations of the wash basin throughout the day.

The average shower flow rate at the hotel was 6.5 lpm, below the maximum recommended flow rate. It was estimated that the second largest domestic water use at the Ambassador is in the shower. There is no recommendation for a shower-related retrofit at this time, though the hotel should consider upgrading its equipment. The low flow rate is not necessarily due to the showerhead itself, but also low building pressure. Variations in pressure between the cold and hot water systems can incrementally affect showerhead flow rates, which can substantially increase consumption over time. Furthermore, higher pressures on lower floors can generate consumption increases at fixtures closer to the ground floor. Pressure-compensating showerheads will eliminate concerns related to pressure differential and standardize flow rates.

Hotel lavatory faucets possessed an average flow rate of 8.5 lpm in guest rooms and 7.6 lpm in common area and staff area bathrooms. Installing 4.5 lpm flow controls would cut lavatory faucet consumption by near half across the entire facility, saving water and energy related to hot water usage.

Kitchen lavatories averaged 7.5 lpm and it is recommended to retrofit the existing faucets with 8.3 lpm flow controls. Two flushes per fixture were allotted for bathroom cleaning in occupied guest rooms. The results of the end use water balance are illustrated in the Table below.

Table 7: End uses of water at facility 7

Types	Avg. %	m³/year
Toilets	35%	1,923
Urinals & Bidets	11%	596
Faucets (Kit and Lav)	10%	537
Showers	25%	1,367
Cleaning	4%	192
Com. Kitchen (Food services)	13%	723
Ice Machines	1%	63
Landscape	1%	40
Total		5,441

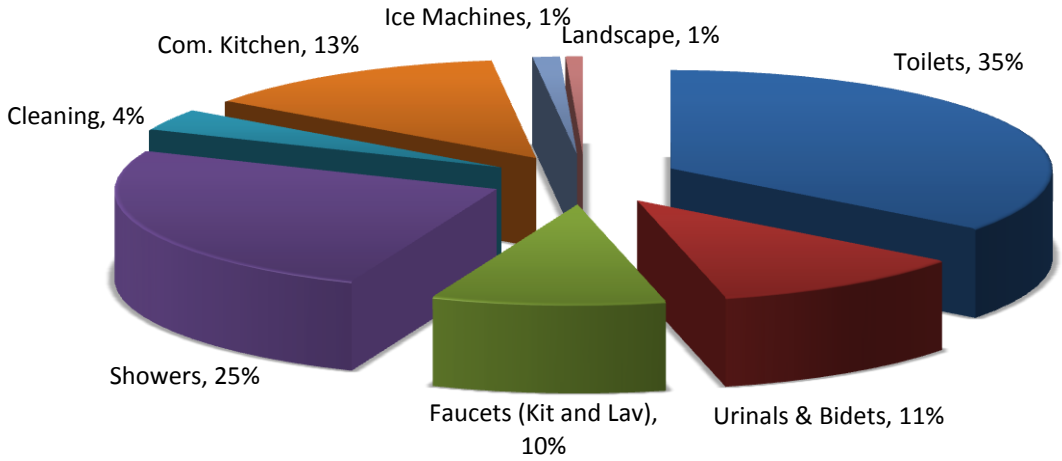

Figure 18: Water use percentages at facility 7

Recommended Measures:

Lavatory Faucets

Lavatory faucet flow rates at the hotel are around 50% higher than recommended. The hotel should retrofit public and common area restrooms with flow controls that use no more than 4.5 lpm. Significant water savings are achievable through such a measure. Depending on occupancy and usage patterns, the hotel could reduce its consumption by 15% by installing faucet aerators.

Toilets

Toilet tanks should be retrofitted with 6 lpf that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Showerheads

The showerheads in the guest rooms operate at an average flow rate of 6.5 lpm. While this flow rate is below the maximum recommended flow rate of 7.6lpm, the audit team measured a variety of shower flow rates during our audit. A shower audited on the 6th floor used 4 lpm, while the same unit on the 2nd floor used 7.8 lpm, nearly double. Pressure-compensating showerheads will reduce flow rates on lower floors by standardizing flow rates. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units.

Potential Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,923
Bidet consumption per year	596
Lavatory consumption per year	209
Shower consumption per year	1,367
Kitchen faucet consumption per year	328
TOTAL DOMESTIC CONSUMPTION	4,423

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,056
Bidet consumption per year	99
Lavatory consumption per year	112
Shower consumption per year	1,367
Kitchen faucet consumption per year	328
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	2,962

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 1,461 m^3 per year, which is equivalent to an annual saving of 27% of total water use.

Facility 8

Background

The facility was built in 1998. The hotel has 85 staff members for 107 rooms. Occupancy is estimated at 60% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day.

Water Balance and End Use Types:

The facility receives water and sewer service from Miyahuna 3 days a week and does not receive supplementary tanker water. The hotel annual water consumption was estimated at 6,170 m^3.

The hotel has no central steam boiler, cooling tower, or water features. It does have a commercial kitchen, swimming pool, Jacuzzi, water softening system, manual landscape irrigation, and commercial laundry operation. These systems are discussed with greater detail in "Recommended Measures". The hotel has a total water storage capacity of 200m^3, with one tank held as 20m^3 of standby storage. Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 7th floor and gravity-fed throughout the building. Water entering the building is softened before distribution.

Domestic fixtures appeared in satisfactory condition and average domestic fixture flow rates were relatively low compared to other hotels and sectors. The toilet fixtures observed were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 6.3 lpf in guest areas, 6 lpf in staff/visitor areas. Bidet trigger hose usage averaged 6 lpm. The average shower flow rate was 5.5 lpm, quite low compared to other hotels. Hotel lavatory faucets operated at 7 lpm, which can be reduced. This low flow is attributed to faucet flow controls, though none were pressure-compensating. Two flushes per fixture were allotted for both bathrooms cleaning in occupied guest rooms. The results of the end use water balance are illustrated in the Table below.

Table 8: End uses of water at facility 8

Facility 8		
Types	**Avg. %**	**m^3/year**
Toilet	27%	1,659
Urinal & Bidet	10%	600
Faucets (Kit and Lav)	10%	594
Showers	19%	1,171
Cleaning	1%	55
Com. Kitchen (Food Services)	11%	657
Laundry	14%	903
Pool Backwash	5%	342
Ice Machines	3%	189
Total		**6,170**

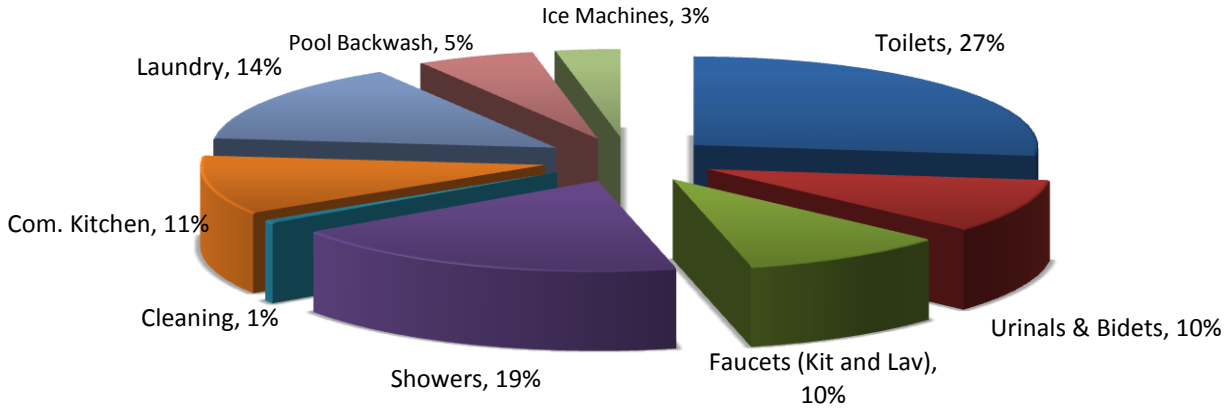

Figure 19: End uses of water at facility 8

Recommended Measures:

Storage and Re-Use

The hotel has a 20m^3 underground storage tank that is separated from all other tanks. The hotel should consider using this tank to recycle water from pool filter backwash, pool blowdown, Jacuzzi blowdown, and laundry final rinse water. This water could be filtered through a variety of methods and reused for laundry rinse. This would also save considerable energy related to preheating laundry water, as the water recycled would already contain higher temperatures from pool & Jacuzzi heating. The facility may also use the filtered water for its small irrigation applications.

Laundry

Laundry rinse water should be recycled and used for wash cycles. While most of the laundry machines the hotel uses are residential, top loaders, they also have 6kg GE machines, one 25kg Nyborg unit, and one 33kg Nyborg unit. Management informed the audit team they plan to convert to commercial washers as soon as possible. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. Recovering final rinse water is not as cost intensive as installing processes that can recover up to 80% of water consumed per cycle. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

Figure 20: clothes washers at Facility 8

Swimming Pool

The hotel has one indoor 80 m^3 swimming pool and two Jacuzzis totaling 10 m^3. The facility staff informed the team that it drains and refills the pools every 4 months. This is unnecessary

with proper maintenance and should be limited to annually or every 6 months at the most. The Jacuzzis are drained daily and the hotel should consider recycling this water for laundry use after filtering. The sand filter for the pool does not have an automatic backwash; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal.

Lavatory & Kitchen Faucets

Faucet flow rates are quite reasonable when compared to the local standards and other audit results. However, by retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 45% of the lavatory water use and additional energy costs associated with hot water production and boiler operation.

It is recommended to retrofit kitchen faucets at the facility with pressure-compensating flow controls. While usage of these units is limited to employees, the usage is likely considerable for kitchen employees. And because consumption in the kitchen is more behaviorally-dependent than other non-domestic categories, reducing flow rates on these kitchen faucets is necessary to reduce the overall number of liters consumed per meal.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,659
Bidet consumption per year	600
Lavatory consumption per year	265
Shower consumption per year	1,171
Kitchen faucet consumption per year	329
TOTAL DOMESTIC CONSUMPTION	4,024

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,063
Bidet consumption per year	99
Lavatory consumption per year	170
Shower consumption per year	1,171
Kitchen faucet consumption per year	181
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	2,684

Based in the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 1340 m^3 per year, which is equivalent to an annual saving of 22% of total water use.

Facility 9

Background:

The Hotel has only been in operation for 2-3 months after its renovation at the time of audit. The hotel has 85 staff members for 121 rooms. Occupancy is estimated at 65% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day.

Water Balance and End Use Types:

The hotel receives water and sewer service from Miyahuna 3-6 days a week and does not receive supplementary tanker water. The hotel water use was estimated at 5,181 m^3 annually.

The hotel has no central steam boiler, cooling tower, or water features. It does have a commercial kitchen, swimming pool, Jacuzzi, water softening system, manual landscape irrigation, and commercial laundry operation. These systems are discussed with greater detail in "Recommended Measures". The hotel has a total water storage capacity of 180 m^3. Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 7th floor and gravity-fed throughout the building. Water entering the building is softened before distribution.

Domestic fixtures appeared in good condition. Staff bathrooms, staff lockers, kitchens were all sopping wet. This demonstrates inefficient cleaning practices and the hotel should place more emphasis on employee education to reduce utility costs. The toilet fixtures observed were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had flush towers and ball float mechanisms that dispensed an excellent average of 5 lpf in guest areas, but over 8 lpf in staff and visitor areas. Bidet trigger hose usage averaged 7 lpm. The average shower flow rate was 12 lpm, quite high compared to other hotels and certainly an area in which the hotel can inexpensively limit consumption. Hotel lavatory faucets operated at an average of 9.5 lpm in guest rooms, and 7.6 lpm in staff/visitor areas. These numbers are far too high and should be reduced through the application of pressure-compensating flow controls.

Two flushes per fixture were allotted for both bathroom cleaning in occupied guest rooms and non-bathroom surfaces. The results of the end use water balance are illustrated in the Table below.

Table 9: End uses of water at facility 9

Types	Avg. %	m^3/year
Toilets	31%	1,627
Urinals & Bidets	4%	200
Faucets (Kit and Lav)	12%	647
Showers	30%	1,551
Cleaning	3%	163
Com. Kitchen Food Services	5%	237
Laundry	8%	431
Pool Evaporation	3%	156
Pool Backwash, Decorative Fountains	2%	104
RO/Filtration	1%	65
Total		**5,181**

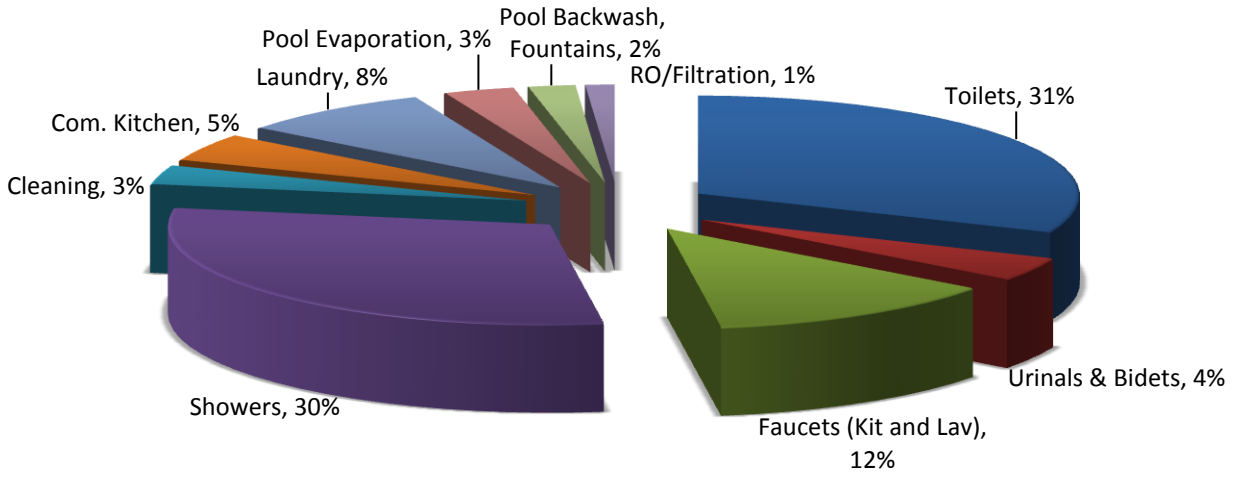

Figure 21: Water use percentages at facility 9

Recommended Measures:

Showerheads

The showerheads in the guest rooms operate at an average flow rate of 12 lpm, based on units measured. As discussed above, retrofitting these units with pressure compensating, 7.6 lpm maximum units can reduce shower consumption by at least 30%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Swimming Pools

The hotel has one outdoor 80 m^3 swimming pool. The sand filter for the pool does not have an automatic back wash instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. The hotel claims to backwash 1m^3 once or twice a week. This usage is considerable and perhaps largely avoidable. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel should also install a physical or chemical pool cover to limit evaporative loss. Since the pool is outdoors it is exposed to significant temperature differentials, especially in the spring and autumn months which will consistently erode water levels in the pool through evaporation. A pool cover will limit water and heat loss by establishing a barrier between the pool and the ambient air.

Laundry

Laundry rinse water should be recycled and used for wash cycles. Currently, the hotel has one 20 kg Unimac unit and one 35kg Nyborg unit. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. Recovering final rinse water is not as cost intensive as installing processes that can recover up to 80% of water consumed per cycle. It will also save energy costs associated with pre-heating that wash water for application. This

water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

Lavatory & Kitchen Faucets

Retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls could save approximately 50% of lavatory water use and additional energy costs associated with hot water production and boiler operation.

It is also recommended to retrofit kitchen faucets at the hotel with pressure-compensating flow controls. While usage of these units is limited to employees, the usage is likely considerable for kitchen employees. And because consumption in the kitchen is more behaviorally-dependent than other non-domestic categories, reducing flow rates on these kitchen faucets is necessary to reduce the overall number of liters consumed per meal.

Toilets

Toilet tanks should be retrofitted with 6lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Reverse Osmosis

The kitchen has one Scotsman ice machine that is equipped with an RO system to purify water used to make ice. This process rejects approximately 4 liters of water for ever liter of produced to make ice. The remaining 4 liters are wasted to drain. The hotel should consider recovering this water for alternative purposes such as floor washing in the kitchen, as make-up water in the dish machine, or sent to the pool or laundry for use.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,627
Urinal consumption per year	0.221
Bidet consumption per year	199
Lavatory consumption per year	263
Shower consumption per year	1,551
Kitchen faucet consumption per year	384
TOTAL DOMESTIC CONSUMPTION	4,025

Building Domestic Subtotals – Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,200
Urinal consumption per year	0.221
Bidet consumption per year	28
Lavatory consumption per year	128
Shower consumption per year	982
Kitchen faucet consumption per year	181
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	2,520

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 1505 m^3 per year, which is equivalent to an annual saving of 29% of total water use.

Four Star Hotels

Facility 10

Background

The Hotel was built in 1976. It has 120 staff members for 173 rooms. Occupancy is estimated at 55% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The Hotel has the largest number of guest rooms of any "3/4 Star" hotel in the touristic sector.

Water Balance and End Use Types

The Hotel receives two-thirds of its water from Miyahuna and the remaining third from supplementary tanker water. . The water use consumption was estimated at 25,193 m^3 per year.

The hotel has no cooling tower or water features. It does have a commercial kitchen, swimming pool, Jacuzzi, water softening system, manual irrigation, steam boiler system, and commercial laundry operation. These systems are discussed with greater detail in "Recommended Measures". Water is pumped to the roof from basement and underground tanks to rooftop tanks above the 11th floor and gravity-fed throughout the building. Water entering the building is softened before distribution.

Figure 22: Some plumbing fixtures at Facility 10

Domestic fixtures appeared in good condition; however they used significantly more water than necessary. While the hotel had the most non-domestic systems of a "3/4 Star" hotel, it still used the majority of its water domestically. The toilet fixtures observed were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 8.5 lpf in guest areas, but just over 5 lpf in staff and visitor areas, as some staff toilets were "Turkish". Retrofit of existing guest room toilets could save the hotel over 30% of toilets water use if the hotel installed dual-flushing tanks. Visitor areas had commercial style fixtures with flush valves. Bidet trigger hose usage averaged 4 lpm. The average shower flow rate was nearly 8 lpm and staff/visitor showers averaged nearly 19 lpm! Hotel lavatory faucets operated at an average of 7.6 lpm in guest rooms, and 10 lpm in staff/visitor areas. These numbers are far too high and should be reduced through the application of pressure-compensating flow controls.

Two flushes per fixture were allotted for both bathroom cleaning in occupied guest rooms and non-bathroom surfaces cleaning are estimated at 746 m^3 per year based on the sector assumptions. The results of the end use water balance are illustrated in the Table below.

Table 10: End uses of water at Facility 10

Types	Avg. %	m³/year
Toilets	18%	4,565
Urinals & Bidets	5%	1155
Faucets (Kit and Lav)	10%	2456
Showers	26%	6,608
Cleaning	4%	913
Com. Kitchen (Food Services)	15%	3,789
Laundry	6%	1,566
Pool Evaporation	1%	208
Ice Machines	2%	470
RO/Filtration	2%	456
Landscape	3%	646
Boiler Make-Up	8%	2,100
Others	1%	261
Total		**25,193**

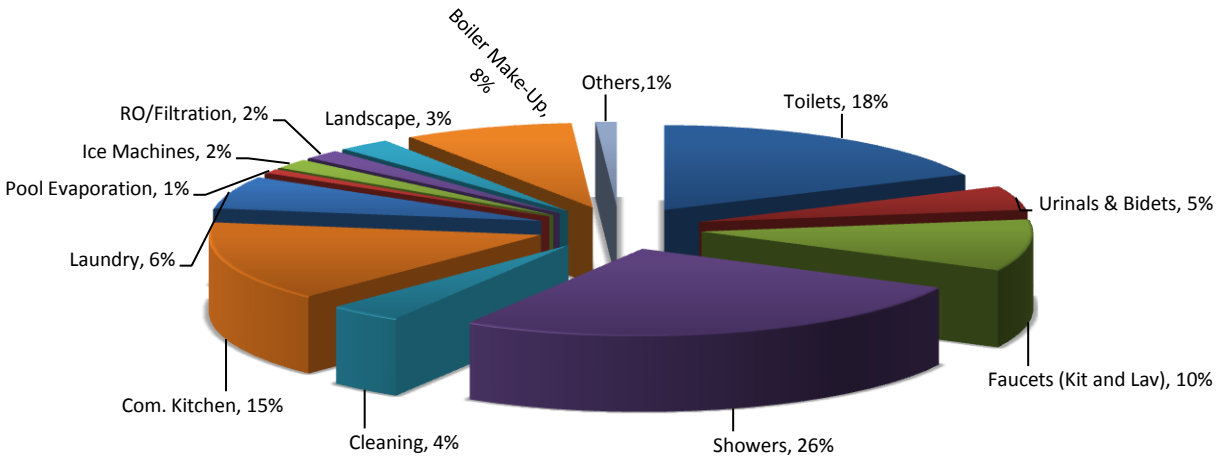

Figure 23: Water use percentages at facility 10

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Laundry

Laundry rinse water should be recycled and used for wash cycles. Currently, the hotel has one 40 kg unit, one 16 kg unit, two 5kg units, and one 4kg unit. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. Recovering final rinse water is not as cost intensive as installing processes that can recover up to 80% of water consumed per cycle. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

Lavatory & Kitchen Faucets

Faucet flow rates are quite reasonable when compared to the Jordanian standards and the audit results. However, by retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 50% of lavatory water use and additional energy costs associated with hot water production and boiler operation.

It is also recommended to retrofit kitchen faucets at the hotel with pressure-compensating flow controls. While usage of these units is limited to employees, the usage is likely considerable for kitchen employees. And because consumption in the kitchen is more behaviorally-dependent than other non-domestic categories, reducing flow rates on these kitchen faucets is necessary to reduce the overall number of liters consumed per meal.

Showerheads

The showerheads in the guest rooms operate at an average flow rate over 8 lpm, based on units measured in guest, staff, and visitor areas. As discussed above, retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by at least 5%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units.

Steam Boiler Make-Up

Currently, the technician in the hotel blows down its boiler when the total dissolved solids content of the water in the boiler is too high based on personal judgment. While "TDS" can be and often measured by maintenance staff to initiate a blowdown procedure, too often the system is blowndown arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. The boiler make up was calculated at the facility

assuming that boiler ran 5 cycles of concentration, used approximately 350,000 liters of diesel fuel per year, and recovered 60% of steam condensate.

Swimming Pools

The hotel has one indoor 80 m^3 swimming pool. The sand filter for the pool does not have an automatic backwash; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	4,565
Urinal consumption per year	5
Bidet consumption per year	1,150
Lavatory consumption per year	1,524
Shower consumption per year	6,608
Kitchen faucet consumption per year	932
TOTAL DOMESTIC CONSUMPTION	14,784

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	2,455
Urinal consumption per year	1
Bidet consumption per year	287
Lavatory consumption per year	789
Shower consumption per year	6,102
Kitchen faucet consumption per year	932
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	10,566

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 4,218 m^3 per year, which is equivalent to an annual saving of around 17% of the total water use.

Facility 11

Background:

The hotel was first a clinic for doctors but in 1998 it was closed and then renovated into a hotel. The hotel has 120 rooms with an average occupancy of 90-95%. The staff number is 225 . The facility is a 4 star hotel that is privately owned and is not connected to any international hotel chain. Each day the hotel has an average number of 120-150 visitors.

Water Balance and End Use Types:

The annual water consumption was estimated at 20,418 m^3. The hotel does not have a laundry or any fountains. There is only a very small area that is landscaped. The swimming pool has a total volume of 200 m^3 and is backwashed every day. The kitchen does not have any water cooled equipment. The refrigeration and ice machines are all air cooled. The kitchen has 4 dishwashers. The public restroom on the first floor was audited and the toilet use was 6 lpf and was in good condition, the audit for the faucets revealed an average flow rate of 8 lpm.

Table 11: End use of water at facility 11

Types	Avg. %	m^3/year
Toilets	23%	4,650
Urinals & Bidets	6%	1169
Faucets (Kit and Lav)	8%	1696
Showers	40%	8,248
Cleaning	2%	465
Com. Kitchen (Food services)	9%	1,752
Laundry	9%	1,774
Ice Machines	2%	319
RO/Filtration	2%	345
Total		**20,418**

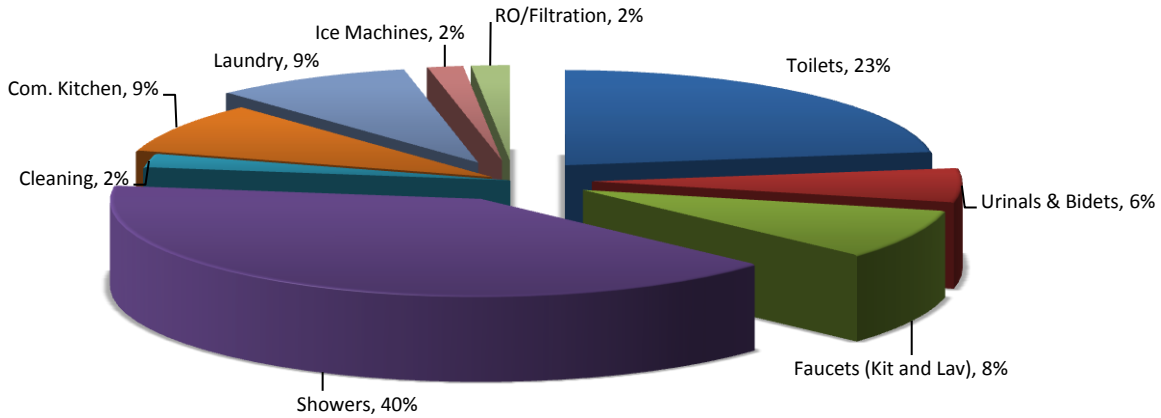

Figure 24: Water use percentages at Facility 11

Recommended measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory & Kitchen Faucets

Faucet flow rates are quite reasonable when compared to the Jordanian standards and the audit results. However, by retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 50% of lavatory water use and additional energy costs associated with hot water production and boiler operation. It is also recommended to retrofit kitchen faucets at the hotel with pressure-compensating 8.3 lpm flow controls.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	4,650
Urinal consumption per year	11
Bidet consumption per year	1,158
Lavatory consumption per year	1,257
Shower consumption per year	8,248
Kitchen faucet consumption per year	439
TOTAL DOMESTIC CONSUMPTION	15,763

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	3,084
Urinal consumption per year	3
Bidet consumption per year	289
Lavatory consumption per year	993
Shower consumption per year	8,248
Kitchen faucet consumption per year	364
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	12,981

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 2,782 m^3 per year, which is equivalent to an annual saving of 14% of the total water use.

Facility 12

Background Information

This Hotel in the city of Aqaba is a four star hotel that is composed of 200 rooms in a 6000 m^2 building with a total surface area of 7,500 m^2. . The structure was built in 1992 and has a staff count of 114 employees that work 8 hour shifts 365 days a year. The hotel receives an average of 30 visitors a day. During the winter months, which encompass 7 months of the year, the hotel has 35% occupancy with approximately 140 guests a day. The summer months, 5 months, has 50% occupancy with approximately 200 guests a day. Each room typically hosts two guests.

Water Balance and End Use Types:

The hotel receives water 24 hours a day, 7 days a week from the Aqaba Water Company. The estimated annual consumption was 23,769 m^3.

Figure 25: Flushing device at hotel 12

The Hotel's bathrooms contain tank toilets that flush at 8.3 lpf. The hotel has 224 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. One "Turkish" style toilet is in use at this site with an average flow rate of 6 lpf, assuming the water used is in the form of vessels or buckets. This location has one urinal that flushes at 2 lpf and 5 bidets that have an average flow rate of 4.5 lpf. The total showerhead count is 203 with an average flow rate of 7.1 lpm. There are 223 lavatory faucets that operate at 5.2 lpm.

The hotel has a kitchen that produces a daily average of 180 breakfast meals, 40 lunch meals and 120 dinner meals. All the meals are served on china plates, therefore requiring them to be washed down by one pre rinse nozzle at 7.2 liters per minute (lpm) before being placed in the dishwasher. The dish washer endures 36 loads per day at 7 liters per load. There are 6 sinks present, each with 18 liter capacity that is filled 12 times a day. An additional two lavatory faucets each with a flow rate of 6.2 lpm are available for hygiene. The kitchen floors are hosed down three times a day for an average of 16 minutes at a flow rate of 4 lpm.

In this hotel the water used to irrigate the turf is derived from two different sources. 60% of the water used for irrigation comes from the pool's backwash while the other 40% is fresh non potable water. A total of 2,000 liters a day is used towards watering the turf manually using 11 lpm hoses.

The swimming pool present in this hotel is heated with a total volume of 275$m^3$and a surface area of 180m^2. 1200 liters from the backwash of the pool are used for landscape irrigation purposes at this site.

There are three washing machines that use a total of 20 m^3 a month combined on an average basis. The hotel uses two resin capacity water softeners which operate at 15 m^3 and 14 m^3.

Table 12: End uses of water at facility 12

Facility no. 12		
Types	**Avg. %**	**m³/year**
Toilet	24%	5,598
Urinals & Bidets	4%	977
Faucets (Kit and Lav)	9%	2144
Showers	14%	3,259
Cleaning	4%	888
Com. Kitchen (Food Services)	10%	2,482
Laundry	10%	2,409
Pool Evaporation	2%	468
Pool Backwash	4%	1,027
Ice Machines	1%	325
RO/Filtration	1%	171
Landscape	13%	2,976
Boiler Make-Up	1%	300
Others	3%	745
Total		**23,769**

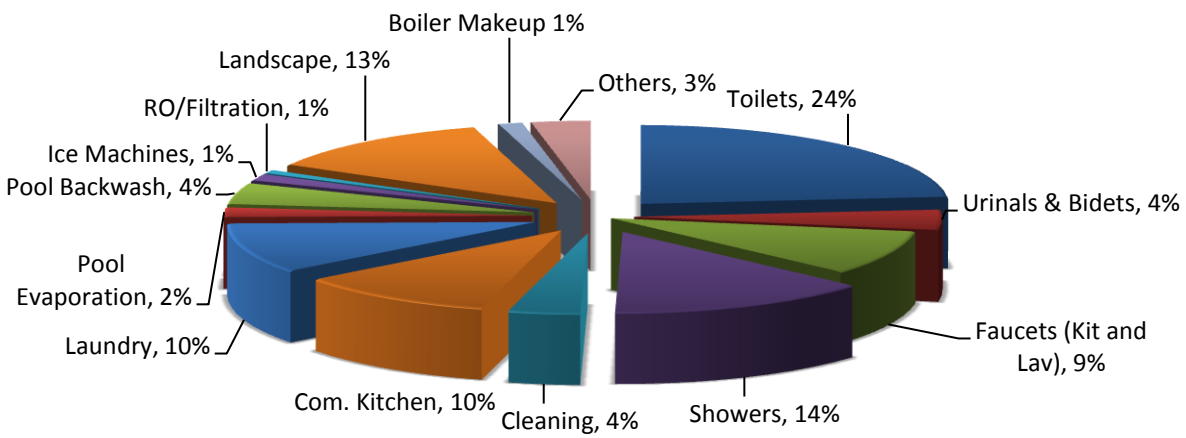

Figure 26: Water use percentages at facility 12

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Lavatory & Kitchen Faucets

Faucet flow rates exceed the Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 7% of lavatory water use and additional energy costs associated with hot water production and boiler operation.

Laundry

The hotel's has three washing machine units that should be retrofitted. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	5,598
Urinal consumption per year	1
Bidet consumption per year	976
Lavatory consumption per year	567
Shower consumption per year	3,259
Kitchen faucet consumption per year	1,577
TOTAL DOMESTIC CONSUMPTION	11,978

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	2,697
Urinal consumption per year	0.649
Bidet consumption per year	216
Lavatory consumption per year	490
Shower consumption per year	3,259
Kitchen faucet consumption per year	1,090
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	7,755

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 4,223 m^3 per year which is equivalent to 18% reduction of the total water use.

Facility 13

Background Information

This is a four star hotel in Aqaba. It is has 109 rooms in a 10,000 m^2 building with a total surface area of 2,700 m^2. The facility was built in 1995 and underwent a series of upgrades in 2002, including the installation of new toilets on two floors of the building. The hotel has a staff count of 55 employees that work 8 hour shifts 365 days a year. The hotel receives an average of 30 visitors a day. The typical occupancy is around 50% with approximately 110 guests a day.

Water Balance and End Use Types:

The hotel receives water 24 hours a day, 7 days a week from Aqaba Water Company. The water consumption was estimated at 15,069 m^3 per year.

The Hotel's bathrooms contain western type toilets that flush at 5.8 lpf. The hotel has 126 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 1 urinal that flushes at 2 lpf and 109 bidets that have an average flow rate of 4.8 lpf. The total showerhead count is 110 with an average flow rate of 10.4 lpm. There are 122 lavatory faucets that operate at 4.5 lpm.

The hotel has a kitchen that produces a daily average of 100 breakfast meals, 20 lunch meals and 50 dinner meals. All the meals are served on china plates and washed in the three sinks present, each with 20 liter capacity that is filled 12 times a day with the faucets running at 4.3 liters per minute. The kitchen floors are mopped three times a day using 4 liters of water in a bucket each time (12 liters per day). There is one air cooled chest type freezer and one air cooled ice maker medium in size in the kitchen area; both are in good condition. There are two washing machines that are in good condition with each having a 23.5 kg capacity and each washing 11 loads per day at 70 liters per load; thus using 770 liters of water daily. The hotel is air conditioned with a 287.5 ton unit. In addition, the hotel has one hot water boiler.

Figure 27: Roof top pool at facility 13

There are potted plants on the grounds that receive approximately 500 liters of water per week. The swimming pool present in this hotel has a total volume of 39 m^3 and a surface area of 31 m^2. The hotel staff manually backwashes 300 liters per day. Approximately 0.5 m^3 is lost daily due to evaporation. The results of the end use water balance are illustrated in the Table below.

Table 13: End uses of water at facility 13

Types	Avg. %	m³/year
Toilet	23%	3,436
Urinals & Bidets	10%	1543
Faucets (Kit and Lav)	11%	1667
Showers	21%	3,135
Cleaning	9%	1,329
Com. Kitchen (Food Services)	8%	1,241
Laundry	11%	1,606
Pool Evaporation	1%	81
Pool Backwash	1%	109.5
Ice Machines	1%	217
RO/Filtration	1%	133
Landscape	0.5%	78
Others	3%	493
Total		**15,069**

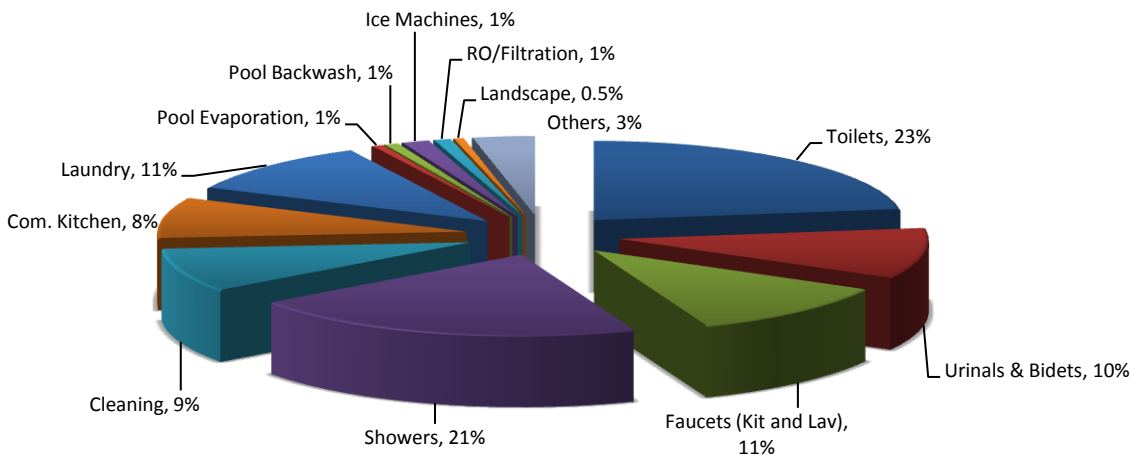

Figure 28: water use percentages at facility 13

Recommended Measures

Showerheads

As discussed above, retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 26%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel has two machine units that should be considered for retrofitting. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Pool

The hotel has an outdoor (39m^3) swimming pool. The sand filter for the pool does not have an automatic backwash; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	3,436
Urinal consumption per year	0.885
Bidet consumption per year	1,542
Lavatory consumption per year	1,102
Shower consumption per year	3,135
Kitchen faucet consumption per year	565
TOTAL DOMESTIC CONSUMPTION	9,781

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	2,290
Urinal consumption per year	0.443
Bidet consumption per year	321
Lavatory consumption per year	1,102
Shower consumption per year	2,291
Kitchen faucet consumption per year	565
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	6,569

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 3,212m^3 per year which is equivalent to 21% reduction of total water usage.

Facility 14

Background Information

The four star hotel has 80 rooms in a 21,800m^2 building. The structure was built in 2000 and underwent a series of room upgrades in 2007 and has a staff count of 52 employees that work 8 hour shifts 365 days a year. The hotel has an outside café which receives 45 customers per day. The hotel typically reaches 60% occupancy with approximately 96 guests a day.

Water Balance and End Use Types:

The Hotel receives water 24 hours a day, 7 days a week from Aqaba Water Company. The water consumption was estimated at 9,258m^3 per year.

The Hotel's bathrooms contain tank toilets that flush at 4.4 lpf. The hotel has 92 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. All 80 hotel room bathrooms have toilet spray hoses that spray at 4lpm. This location has 2 urinals that flush at 2.8 lpf and 6 bidets that have an average flow rate of 5.2 lpf. The total showerhead count is 83 with an average flow rate of 12.8lpm. There are 92 lavatory faucets that operate at 7.9 lpm.

The hotel has a kitchen that produces a daily average of 80 breakfast meals, 20 lunch meals and 80 dinner meals. All the meals are served on china plates, therefore requiring them to be washed down by one pre rinse nozzle at 13. lpm before being placed in the dishwasher. The dish washer endures 25 loads per day at 5 liters per load. There are 5 sinks present, each with 20 liter capacity that is filled 22 times a day. An additional two hand sinks are available for hygiene. The kitchen floor spans 250 m^2 and is moped 3 times a day which requires a bucket be filled at a flow rate of 6 liters per minutes.

Figure 29: Hotel's restaurant – Facility 14

There is no landscape irrigation used at this hotel. However, there are potted flowers around the grounds which require watering at 500 liters per day in the summer (5 months per year) and 200 liters per day in the winter (7 months per year). The swimming pool present in this hotel has a total volume of 1000 m^{3}and a surface area of 60 m^2. The pool is not heated nor covered. It is backwashed once daily by manually which uses roughly 50 liters per day (averaging 18,250 l/yr). It uses one filter daily that has a recirculating flow rate. One cubic meter of make-up water is manually added on a daily basis (averaging 365 m^3 per year).

There are two washing machines that use a total of 960 liters combined on a daily basis. One is large machine that uses 70 liters per load and is run roughly 8 times per day; the second washer is medium in size using 50 liters per day and is run roughly 8 times per day. The hotel is an air-conditioned facility using a unit with a 240 ton capacity. In addition, they use two hot water boilers. The Hotel uses a reverse osmosis system that makes 10 liters per day max. The results of the end use water balance are illustrated in the Table below.

Table 14: End uses of water at facility 14

Types	Avg. %	m³/year
Toilets	23%	2,147
Urinal & Bidet	10%	905
Faucets (Kit and Lav)	13%	1203
Showers	20%	1,891
Cleaning	6%	584
Com. Kitchen	14%	1,314
Laundry	4%	350.4
Pool Evaporation	2%	156
Pool Backwash	4%	342
Ice Machines	2%	189
RO/Filtration	1%	60
Landscape	1%	117
Total		**9,258**

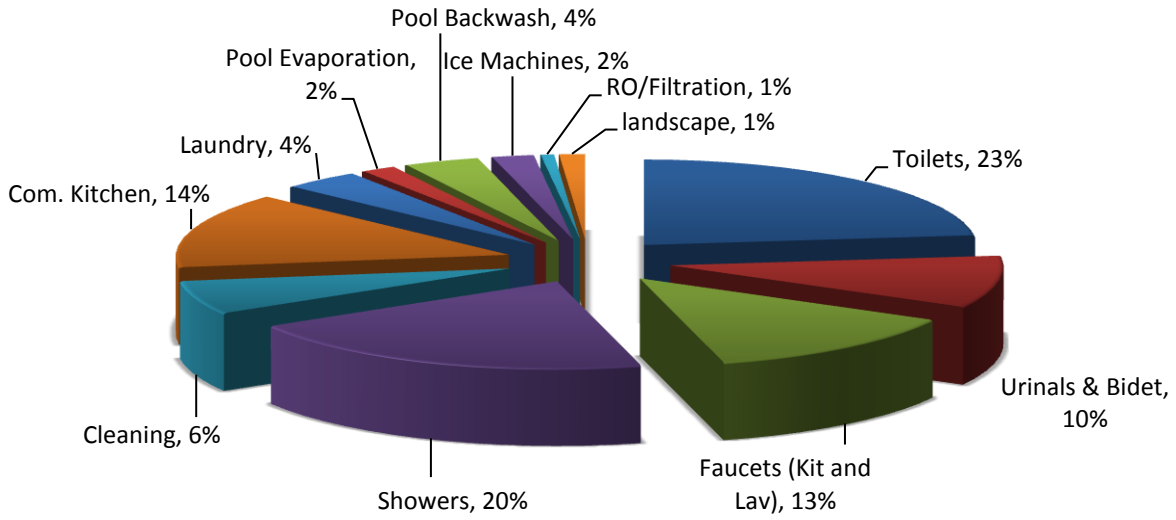

Figure 30: Water use percentages at facility 14

Recommended Measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf or less fixed-volume flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets 3l/6l.

Lavatory & Kitchen Faucets

Faucet flow rates exceed the Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 43% of lavatory water use and additional energy costs associated with hot water production and boiler

operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Showerheads

As discussed above, retrofitting these units with pressure compensating, 7.6 lpm maximum units can reduce shower consumption by 40% when weighting varying flow rates in guest and staff areas. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel's two large commercial washing machines should be retrofitted. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Swimming Pools

The hotel has an outdoor swimming pool. The sand filter for the pool does not have an automatic blowdown; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	2,147
Urinal consumption per year	4
Bidet consumption per year	900
Lavatory consumption per year	624
Shower consumption per year	1,891
Kitchen faucet consumption per year	579
TOTAL DOMESTIC CONSUMPTION	6,145

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,952
Urinal consumption per year	1
Bidet consumption per year	193
Lavatory consumption per year	355
Shower consumption per year	1,122
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	3,986

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 2159 m^3 per year which is equivalent to 23% of the total water use.

Facility 15

Background Information

The four star hotel in Aqaba was built in 2008. It is composed of 260 rooms in 12 buildings. The surface area of each building is 6,018m^2, the total surface area of all buildings and property is 14,486 m^2. The hotel has a staff count of 175 employees that work 8 hour shifts 365 days a year. The hotel typically reaches 33% occupancy in the spring/summer months with roughly 172 guests per day; for the remaining 7 months of the year the hotel is typically at 17% occupancy with 88 guests checked-in per day.

Water Balance and End Use Types:

The Hotel receives water 24 hours a day, 7 days a week from the Aqaba Water Company. The water consumption was estimated at 14,462 m^3 per year. The Hotel's bathrooms contain western type toilets that flush at 5.7 lpf. The hotel has 280 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 10 urinals that flush at 2lpf. The total showerhead count is 265 with an average flow rate of 8.7lpm. There are 290 lavatory faucets that operate at 7.8lpm.

Figure 31: swimming pools at hotel 15

The hotel has a kitchen that produces a daily average of 125 breakfast meals, 20 lunch meals and 100 dinner meals. All the meals are served on china plates; therefore requiring them to be washed down by two pre rinse nozzles; one large which sprays at 7.6 lpm and one small which sprays at 9.2 lpm before being placed in the dishwasher. There are two dish washers (brand: Whirlpool); the large dishwasher washes 4 loads per day at 8 liters and the smaller washer runs 3 loads per day at 3 liters. There are 10 sinks present, each faucet running at 8.6 liters per minute. An additional lavatory sink is available for hygiene which run at 7.2 liters per minute. The kitchen floors are hosed down two times daily at a rate of 4 liters per minute for 12 minutes. The kitchen contains steamers and 2 kettles. The staff typically thaws meat in the sink. They use air cooled freezers and 4 air cooled icemakers varying in size (1 small, 1 large, two medium).

The hotel uses landscape irrigation for the 75 m^2 of turf and 125 m^2 of beds. There is a sprinkler system installed. This would not account for more than 2% of the water use for irrigation. There decorative fountains on the grounds that are approximately 1,000 m^2 and have a daily evaporation rate of 0.5 m^3.

The swimming pool present in this hotel is not heated with a total volume of 890 m^{3}and a surface area of 735 m^2. The pool is not covered. It is manually backwashed daily at a rate of 25 m^3 per day. Two filters are backwashed daily. On the grounds there is a spa with a total volume of 2 m^3 and a surface area of 1.5 m^2. Evaporation rates are on average 0.5 m^3 per day.

The hotel is an air-conditioned facility using 260 units that have a 2 ton capacity for guest rooms and in the main building using a unit that has a 50 ton capacity.

Table 15: End uses of water at facility 15

Types	Avg. %	m³/year
Toilets	19%	2,760
Urinals & Bidets	1%	86
Faucets (Kit and Lav)	10%	1398
Showers	25%	3,607
Cleaning	3%	367
Com. Kitchen food services	9%	1,341
Laundry	5%	822
Pool Evaporation	13%	1,911
Pool Backwash	12%	1,692
Ice Machines	1%	222
RO/Filtration	1%	112
Landscape	1%	144
Total		**14,462**

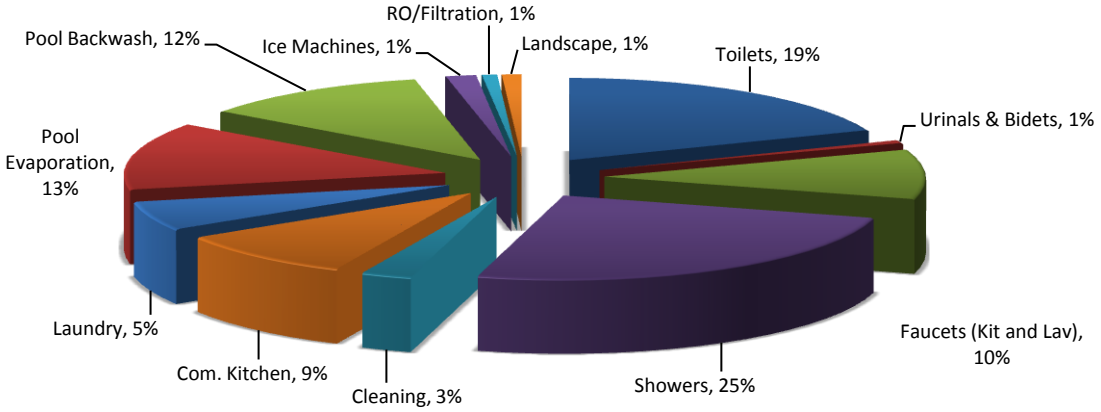

Figure 32 : Water use percentages at facility 15

Proposed Measures:

Toilets

Toilet tanks should be retrofitted with 6lpf or less fixed-volume flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float.
To further reduce consumption, the hotel should consider installing dual-flush toilets 3L/6L .

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to the Jordanian standards and other audit results. By retrofitting lavatory faucets with pressure-compensating 4.5lpm flow controls, the facility could save approximately 42% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Showerheads

As discussed above, retrofitting these units with pressure compensating 7.6lpm maximum units can reduce shower consumption by 13%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel has three 40kg units, a 12kg unit, and a residential top loader for small items. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Consumption Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	2,760
Urinal consumption per year	34
Lavatory consumption per year	631
Shower consumption per year	3,607
Kitchen faucet consumption per year	767
TOTAL DOMESTIC CONSUMPTION	7,799

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,937
Urinal consumption per year	17
Lavatory consumption per year	364
Shower consumption per year	3,150
Kitchen faucet consumption per year	740
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	6,208

Based on the calculations, if the facility implements the recommended measures it will reduce consumption by 1591 m^3 per year which is equivalent to 11% of the total water use.

Five Star Hotels

Facility 16

Background:

The hotel was constructed in 2002 and has 200 staff members for 292 rooms. Occupancy is estimated at 46% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The hotel also has large meeting rooms that host conferences, weddings, and events as well as a gym open to hotel guests as well as members of the community.

Water Balance and End Use Types:

The hotel receives all of its water and sewer service from Miyahuna and uses no supplementary tanker water. The annual water consumption was estimated at 83,886m^3.
The hotel has nearly every type of water using system in this sector - commercial kitchen, swimming pool, Jacuzzi, water softening system, manual irrigation, steam boiler system, water features, and a commercial laundry operation. Water is pumped throughout the building from a 2,000 m3 of water storage located underneath the hotel. Water entering the building is softened before distribution.

Domestic fixtures appeared in good condition; however they used significantly more water than necessary, particularly showers, faucets, and public area toilets. The toilet fixtures in guest areas observed were dual-flush tank and bowl and had an accompanying bidet fixture. Toilets observed had flush towers and ball float mechanisms that dispensed an excellent average of 5.2 lpf (adjusted for dual-flush volumes) in all areas. The average shower flow rate was 11.4 lpm. The existing showerheads should be replaced with pressure compensating units that use 15-20% less water. Hotel lavatories averaged 10.8 lpm and should be retrofitted as well.

Cleaning in occupied guest rooms and non-bathroom surfaces is estimated at 1,532 m3 per year based on the sector assumptions.

Table 16: End uses of water at facility 16

Types	Avg.%	m^3/year
Toilets	7%	6,224
Urinals & Bidets	5%	3740
Faucets (Kit and Lav)	9%	7737
Showers	15%	12,753
Cleaning	2%	1,991
Com. Kitchen (food services)	5%	4,344
Laundry	12%	9,609
Pool Evaporation	12%	10,000
Pool Backwash, Decorative Fountains	25%	21,275
Ice Machines	1%	641
RO/Filtration	1%	1,208
Landscape	3%	2,636
Boiler Make-Up	2%	1,225
Others	1%	503
Total		83,886

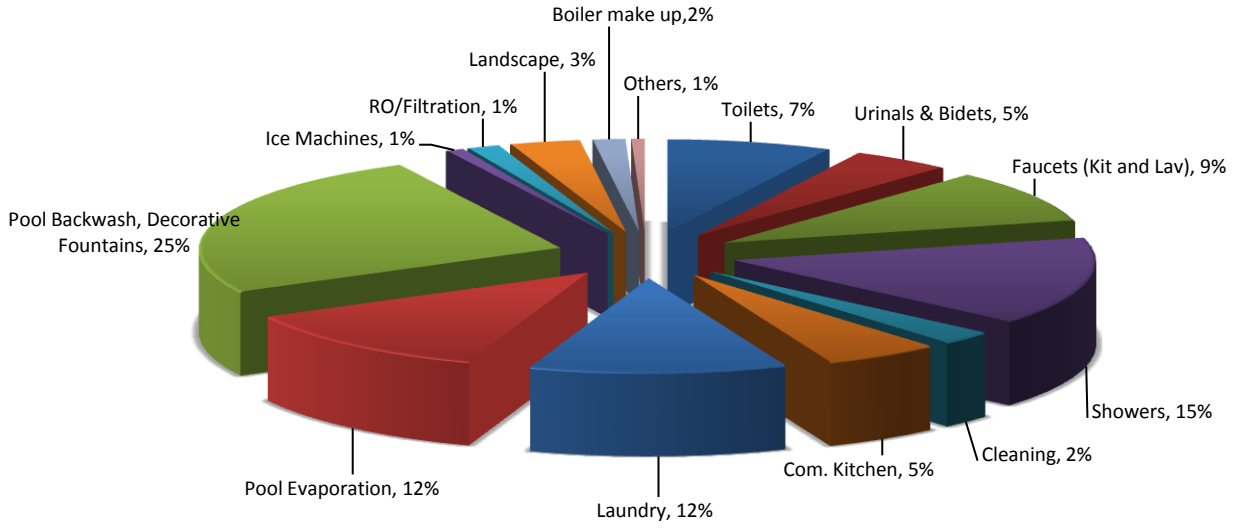

Figure 33: Water use percentages at facility 16

Recommended Measures:

Swimming Pools

The hotel has two indoor (200m^3) and one outdoor (200m^3) swimming pools. It was estimated that nearly 30% of the hotels total consumption is dedicated to pool related use.

The hotel informed the audit team that the 3 sand filters are backwashed 3 times daily with 8m^3 of water. This is flagrant over usage that is far beyond the consumption necessary to successfully backwash the pool. The sand filter for the pool does not have an automatic blow down; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Efficient backwashing of sand filters or replacement of filter media could significantly reduce overall hotel consumption, perhaps by 10-15%.

Figure 34: Boilers at facility 16

Laundry

The hotel has three 100 kg units, one 32 kg machine, one 24 kg unit, one 9 kg unit, and two 5 kg unit. The hotel washes approximately 2,000 kg of laundry per day and had the second largest laundry operation in this sector. The hotel can recover

nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

However, a hotel with a laundry operation as large as facility no. 15 should consider the more expensive, but much more efficient option of recycling laundry water from most cycle stages. Systems are available to reuse water and energy from most wash and all rinse cycles after filtration. Such systems can save large laundry operations between 50-80% of total consumption.

Showerheads

The showerheads in the guest rooms operate at average flow rates of 11.4 lpm, based on the units measured in guest, staff, and visitor areas. As discussed above, retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 33%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to industry standards and other audit results. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 50% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 lpm .

Steam Boiler Make-Up

Currently, steam boilers are blown down based on the personal judgment of the technician on charge. While "TDS" can be and often is measured by maintenance staff to initiate a blowdown procedure, too often the system is blown down arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. The audit team calculated the boiler makeup at the hotel assuming that boiler ran 5 cycles of concentration, used approximately 600,000 liters of diesel fuel per year, and recovered 80% of steam condensate.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	6,224
Urinal consumption per year	10
Bidet consumption per year	3,730
Lavatory consumption per year	6,160
Shower consumption per year	12,753
Kitchen faucet consumption per year	1,577
TOTAL DOMESTIC CONSUMPTION	30,454

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	4,787
Urinal consumption per year	3
Bidet consumption per year	429
Lavatory consumption per year	2,566
Shower consumption per year	8,502
Kitchen faucet consumption per year	1,090
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	17,377

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 13,077 m^3 per year, which is equivalent to an annual saving of 16% of the total water use.

Facility 17

Background:

The Hotel was constructed in 1968. It has 374 staff members for 420 rooms. Occupancy is estimated at 60% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The hotel also has large meeting rooms that host conferences, weddings, and events as well as a gym open to hotel guests as well as members of the community. Nearly one-fifth of the hotel's consumption comes from supplemental water tankers and as such is not verifiable through the utility. Even without that consumption, the hotel is far and away the largest consumer in the touristic sector.

Water Balance and End Use Types:

The Hotel receives four-fifths of its water and sewer service from Miyahuna and the remaining fifth from supplementary tanker water. The water consumption was estimated at 185,651 m^3 per year. The hotel has nearly every type of water using system audited in Hotel buildings - commercial kitchen, swimming pool, Jacuzzi, water softening system, manual irrigation, steam boiler system, cooling tower, water features, and a commercial laundry operation. Water is pumped throughout the building from the 1,500m^3 of water storage located underneath the hotel.

Domestic fixtures appeared in good condition; however they used significantly more water than necessary, particularly showers, faucets, and public area toilets. The toilet fixtures in guest areas observed were dual-flush tank and bowl and had an accompanying bidet fixture. Toilets observed had flush towers and ball float mechanisms that dispensed an excellent average of 5 lpf (adjusted for dual-flush volumes) in guest areas, but just over 9 lpf in staff and visitor areas. Visitor areas had commercial style fixtures with solenoid operated flush valves. These valves can be calibrated to use less water and should be reprogrammed to deliver 4 liters per flush.

The average shower flow rate was 15 lpm in guest rooms and over 19 lpm in staff/visitor showers! This is excessive consumption and consumer satisfaction can be achieved while drastically lowering shower flow rates through the installation of pressure compensating showerheads using 7.6 liters per minute or less. Shower usage was factored as 33% of total hotel usage. Hotel lavatory and kitchen faucets accounted for 4%. They were operating at flow rates nearly identical to those of the showerheads. These numbers are also far too high and should be reduced through the application of pressure-compensating flow controls.

Cleaning in occupied guest rooms and non-bathroom surfaces is estimated at 3825m^3 (2% of total use) per year based on the sector assumptions. The results of the end use water balance are illustrated in the Table below.

Table 17: End use of water at facility 17

Types	Avg. %	m³/year
Toilets	5%	9,838
Urinals & Bidets	3%	5009
Faucets (Kit and Lav)	4%	7507
Showers	33%	61,839
Cleaning	1%	2,353
Com. Kitchen Food	7%	13,140
Laundry	9%	16,556
Pool Evaporation	4%	7,800
Pool Backwash	5%	9,288
Ice Machines	1%	1,242
RO/Filtration	1%	1,840
Landscape	1%	1,614
Cooling Tower	24%	43,800
Boiler Make-Up	2%	3,825
Total		**185,651**

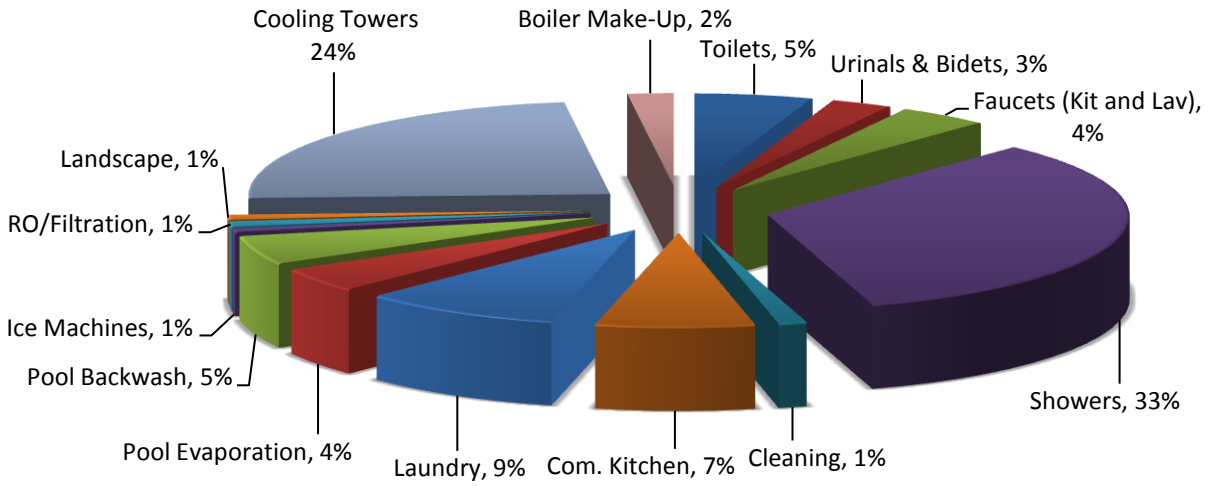

Figure 35: End uses of water at facility 17

Recommended Measures:

Cooling Tower

The hotel has 3 BAC cooling towers. The information on similar size towers from the same manufacturer was utilized to make estimates regarding usage at the hotel. Currently, the towers do not have conductivity controllers that automatically regulate tower blowdown. This leads to unnecessary blowdown; the operator can blow the tower down too often or too long and waste water. A conductivity controller provides a feedback loop that only instructs the tower to blowdown when dissolved solids in the water begin to affect heat transfer and decrease tower efficiency. It was estimated that approximately 24% of the total use of the hotel is devoted to the cooling tower.

Figure 36: part of the Cooling tower system

Additionally, the towers have ball float valves in remote casings that measure tower water levels and prevent overflow. These devices are imprecise, prone to failure, and can lead to tower leakages that can go undetected to untrained staff. These devices should be replaced with electronic float controls that measure water level without moving parts that can become bent, damaged, or break off completely. The hotel should also consider alternative ways to limit cooling tower load, which will in turn limit tower consumption.

Laundry

The hotel has four 150 kg units, and one 60 kg unit. The hotel washed 88,265 kg of laundry during the month of October 2008. The laundry operator estimates the operation consumes up to 100 m^3 daily during peak season. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

Figure 37: Clothes washers a facility 17

However, with this large laundry operation the hotel should consider the more expensive, but much more efficient option of recycling laundry water from most cycle stages. Systems are available to reuse water and energy from most wash and all rinse cycles after filtration. Such systems can save large laundry operations between 50-80% of total consumption.

Showerheads

The showerheads in the guest rooms operate at average flow rates of 15 lpm, based on units measured in guest, staff, and visitor areas. As discussed above, retrofitting these units with pressure compensating, 7.6 lpm maximum units can reduce

Figure 38: Swimming pool at facility 17

shower consumption by up to 50% when weighting varying flow rates in guest and staff areas.

Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction this would provide more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Showers in the gym were especially wasteful as some luxury stalls with multiple jets used in excess of 30 liters per minute.

Lavatory & Kitchen Faucets

Faucet flow rates are very high compared to Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 70% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Swimming Pools

The hotel has an indoor (130m^3) and outdoor (350m^3) swimming pool. The sand filter for the pool does not have an automatic blowdown; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing.

The building engineer backwashes the main sand filter daily with a timed sequence that runs for 10 minutes. The audit team used an ultrasonic flow meter to record a flow of 946 liters per minute while the sequence ran. This equals nearly 10 m^3 of water per day to backwash the filter for only one of the two pools. This usage is excessive, but even if necessary, the hotel could filter and reuse this pool water for irrigation, laundry wash, or cooling tower makeup.

Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Steam Boiler Make-Up

Currently, steam boilers are blown down based on the personal judgment of the technician in charge. While "TDS" can be and often measured by maintenance staff to initiate a blowdown procedure, too often the system is blown down arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. The boiler makeup at the hotel was calculated assuming that the boiler ran 5 cycles of concentration, used approximately 850,000 liters of diesel fuel per year, and recovered 75% of steam condensate.

Water Features

The hotel informed the audit team that the main water feature out front of the hotel is emptied monthly for cleaning. This basin holds an estimated 180 m^3. At the very least, the hotel should consider recycling this water for other purposes instead of dumping to drain. At best, the hotel

should reexamine its maintenance policies regarding the water feature to see if cleaning can be performed without discharging all the water from the fountain.

Toilets

The hotel should examine the calibration of its commercial solenoid valves. Many sampled used well over 6 liters per minute and can easily be reset to deliver lower volumes of water. The toilet fixtures in guest areas are in good shape and are dual-flush units. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 5 lpf (adjusted for dual-flush volumes) in guest areas. Toilets in the staff and visitor areas had commercial style fixtures with solenoid operated flush valves, but they are using an average of 9 lpf. These valves should be reprogrammed to deliver 6 liters per flush. To further reduce consumption, the hotel should consider installing dual-flush toilets 3L/6L.

Potential Domestic Savings:

Building Domestic Subtotals – Consumption m^3/year (Pre Program)	
Toilet consumption per year	9,838
Urinal consumption per year	4
Bidet consumption per year	5,005
Lavatory consumption per year	6,989
Shower consumption per year	61,839
Kitchen faucet consumption per year	517
TOTAL DOMESTIC CONSUMPTION	84,192

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	5,824
Urinal consumption per year	4
Bidet consumption per year	543
Lavatory consumption per year	1,879
Shower consumption per year	30,884
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	39,497

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 44,695 m^3 per year, which is equivalent to an annual saving of 24% of the total water use.

Facility 18

Background:

The hotel was constructed in 1978. It has 213 staff members for 260 rooms. Occupancy is estimated at 67% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The hotel also has large meeting rooms that host conferences, weddings, and events as well as a gym open to hotel guests as well as members of the community.

Water Balance and End Use Types:

The Hotel receives all of its water and sewer service from Miyahuna. The facility annual water consumption was estimated at 55,397m^3. Domestic fixtures appeared in good condition; however they used significantly more water than necessary, particularly showers, faucets, and public area toilets. The toilet fixtures in guest areas observed were dual-flush tank and bowl and had an accompanying bidet fixture. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 7 lpf in guest rooms, and approximately 7.8 lpf in staff and visitor areas. Visitor areas had commercial style fixtures with solenoid operated flush valves. These valves can be calibrated to use less water and should be reprogrammed to deliver 6 liters per flush.

The average shower flow rate was 13.3l pm in guest rooms and 12.5 lpm in staff/visitor showers. Consumer satisfaction can be achieved while cutting shower flow rates nearly in half through the installation of pressure compensating showerheads using 7.6 liters per minute or less. Shower usage was factored as 38% of total hotel usage. Hotel guest room lavatory flow rates averaged 10.5 lpm, while kitchen faucets averaged 13 lpm.

Cleaning in occupied guest rooms and non-bathroom surfaces is estimated at 1,020 m^3 per year based on the sector assumptions. The results of the end use water balance are illustrated in the Table below.

Table 18: End uses of water at Hotel 18

Types	Avg. %	m^3/year
Toilets	15	8,323
Urinals & Bidets	8	4476
Faucets (Kit and Lav)	8	4349
Showers	38	21,371
Cleaning	1	739
Com. Kitchen	8	4,745
Laundry	10	5,716
Pool Backwash	3	1,901
Ice Machines	1	857
RO/Filtration	1	909
Boiler Make-Up	3	1,500
Landscape	4	511
Total		**55,397**

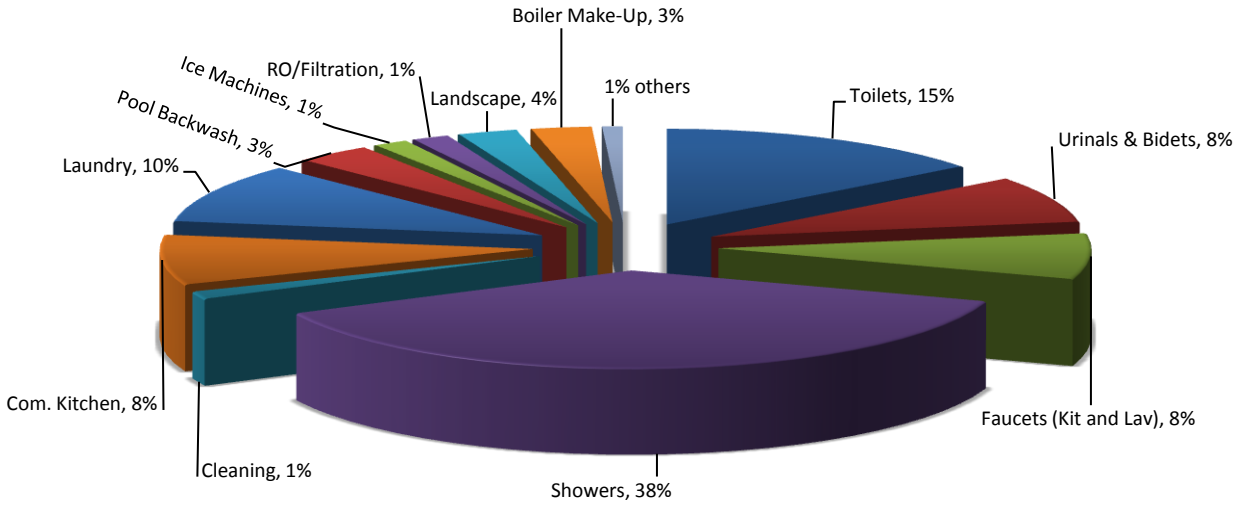

Figure 39: water use percentages at hotel 18

Recommended Measures:

Laundry

The hotel has three 40 kg units, a 12kg unit, and a residential top loader for small items. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Showerheads

Retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 50%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 50% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Toilets

Toilet tanks should be retrofitted with 6.0 lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Steam Boiler Make-Up

The technicians at the hotel blow down its boiler based on their personal judgment of the total dissolved solids content of the water in the boiler. While "TDS" can be and often measured by maintenance staff to initiate a blowdown procedure, too often the system is blown down arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. The boiler make-up was calculated at the hotel assuming that boiler ran 5 cycles of concentration, used approximately 300,000 liters of diesel fuel per year, and recovered 65% of steam condensate.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Figure 40: Irrigation system at the hotel

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	8,323
Urinal consumption per year	3
Bidet consumption per year	4,473
Lavatory consumption per year	3,683
Shower consumption per year	21,370
Kitchen faucet consumption per year	666
TOTAL DOMESTIC CONSUMPTION	38,518

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	4,619
Urinal consumption per year	2
Bidet consumption per year	434
Lavatory consumption per year	1,486
Shower consumption per year	12,242
Kitchen faucet consumption per year	665
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	19,448

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 19,070 m^3 per year, which is equivalent to an annual saving of 33% of the total annual water use.

Hotel 19

Background:

The hotel was constructed in 2000. It has 303 staff members for 268 rooms. Occupancy is estimated at 75% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The hotel also has large meeting rooms that host conferences, weddings, and events.

Water Balance and End Use Types:

The hotel receives approximately 90% of its water from Miyahuna and the remaining 10% is supplementary tanker water. Water consumption was estimated at 79,394 m^3 per year.

The hotel has nearly every type of water using system audited - commercial kitchen, swimming pool, Jacuzzi, water softening system, manual irrigation, steam boiler system, water features, and a commercial laundry operation. Little information regarding storage or infrastructure was available at the time of audit.

Tank toilets observed had flush towers and ball float mechanisms that dispensed an average of 8.8 lpf in guest areas, and 7.6 lpf in staff and visitor areas. The average shower flow rate was 9.7 lpm in guest rooms and 15 lpm in staff/visitor showers. Hotel guest room lavatory flow rates averaged 7.7 lpm, while kitchen faucets averaged 7.3 lpm.

Cleaning in occupied guest rooms and non-bathroom surfaces is estimated at 1,400 m^3 per year based on the sector assumptions. The results of the end use water balance are illustrated in the Table below.

Table 19: End uses of water at Facility 19

Types	Avg. %	m^3/year
Toilets	18%	13,997
Urinals & Bidets	2%	1929
Faucets (Kit and Lav)	9%	6790
Showers	30%	23,857
Cleaning	2%	1,400
Com. Kitchen food services	7%	5,519
Laundry	8%	6,023
Pool Evaporation	2%	1,200
Pool Backwash	10%	8,053
Ice Machines	1%	903
RO/Filtration	1%	1,231
Landscape	4%	3,212
Boiler Make-Up	5%	4,125
Others	1%	1,155
Total		**79,394**

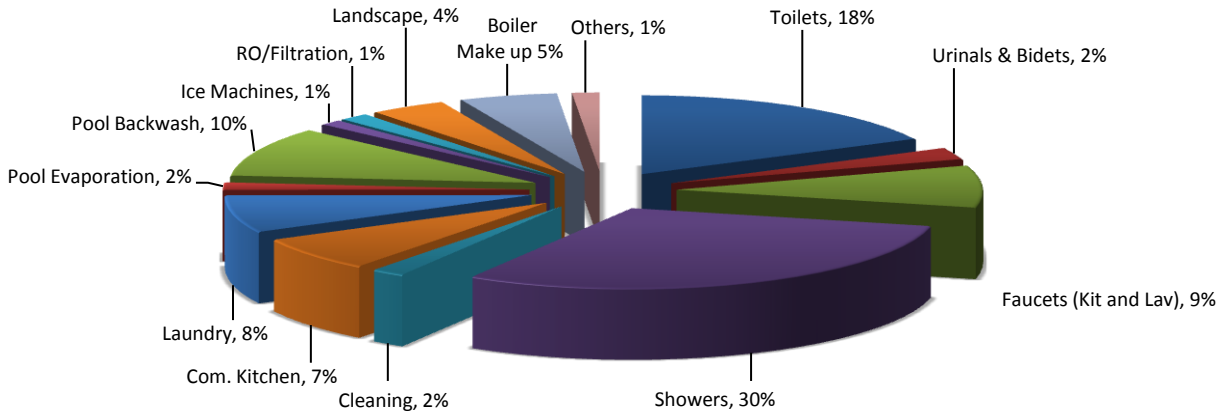

Figure 41: Water use percentages at Hotel 19

Recommended Measures:

Laundry

The hotel has three 114 kg units, and some smaller units. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles.

However, a hotel with a laundry operation as large as this hotel should consider the more expensive, but much more efficient option of recycling laundry water from most cycle stages. Systems are available to reuse water and energy from most wash and all rinse cycles after filtration. Such systems can save large laundry operations between 50-80% of laundry consumption.

Showerheads

Retrofitting the showerheads with pressure compensating, 7.6 lpm maximum units can reduce shower consumption by more than 20%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 40% of lavatory water use and additional energy costs associated with hot water production and boiler

operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Swimming Pools

The hotel has an indoor (150m^3) and outdoor (450m^3) swimming pool. The sand filter for the pool does not have an automatic blowdown; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Steam Boiler Make-Up

The hotel blows down its boiler when maintenance feels the total dissolved solids content of the water in the boiler is too high. While "TDS" can be and often is measured by maintenance staff to initiate a blowdown procedure, too often the system is blown down arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. Boiler make up was assuming that boiler ran 5 cycles of concentration, used approximately 750,000 liters of diesel fuel per year, and recovered 65% of steam condensate.

Toilets

Toilet tanks should be retrofitted with 6.0 lpf tanks that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the hotel should consider installing dual-flush toilets (3L/6L).

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals – Consumption m^3/year (Pre Program)	
Toilet consumption per year	13,997
Urinal consumption per year	2
Bidet consumption per year	1,927
Lavatory consumption per year	5,962
Shower consumption per year	23,857
Kitchen faucet consumption per year	828
TOTAL DOMESTIC CONSUMPTION	46,573

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	6,606
Urinal consumption per year	2
Bidet consumption per year	481
Lavatory consumption per year	3,534
Shower consumption per year	18,669
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	29,655

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 16,918 m^3 per year, which is equivalent to an annual saving of 21% of the total annual water use.

Hotel 20

Background:

The hotel was constructed in 1982. It has 307 staff members for 293 rooms. Occupancy is estimated at 70% annually, with an average of 1.5 people staying in an occupied room for approximately 12 hours per day. The hotel also has large meeting rooms that host conferences, weddings, and events as well as a gym open to hotel guests as well as members of the community. One-fifth of the hotel's consumption comes from supplemental water tankers and as such is not verifiable through the utility.

Water Balance and End Use Types:

The hotel receives four-fifths of its water from Miyahuna and the remaining fifth from supplementary tanker water. Water consumption was estimated at 66,064 m^3 per year.

The hotel has nearly every type of water using system in the audited buildings - commercial kitchen, swimming pool, Jacuzzi, water softening system, manual irrigation, steam boiler system, cooling tower, water features, and a commercial laundry operation. Water entering the building is softened before distribution.

The toilet fixtures in guest areas observed the audit team were dual-flush tank and bowl and had an accompanying bidet fixture. Toilets observed had flush towers and ball float mechanisms that dispensed an excellent average of 5 lpf (adjusted for dual-flush volumes) in guest areas, but just over 7 lpf in staff and visitor areas. Visitor areas had commercial style fixtures with solenoid operated flush valves. These valves can be calibrated to use less water and should be reprogrammed to deliver 6 liters per flush.

Figure 42: Water tanks

The average shower flow rate was 15.6lpm in guest rooms and over 21 lpm in staff/visitor showers! This is excessive consumption and consumer satisfaction can be achieved while drastically lowering shower flow rates through the installation of pressure compensating showerheads using 7.6 liters per minute or less. Hotel guest lavatory faucets averaged 11.3 lpm, while staff and visitor faucets averaged 13.2 lpm. These numbers are also far too high and should be reduced through the application of pressure-compensating flow controls. Guest lavatory flow rates are nearly 3 times the recommended limit.

Cleaning in occupied guest rooms and non-bathroom surfaces is estimated at 1058m^3 per year based on the sector assumptions. The results of the end use water balance are illustrated in the Table below.

Table 20: End uses of water at hotel 20

Types	Avg. %	m³/year
Toilets	16%	10,583
Urinals & Bidets	4%	2877
Faucets (Kit and Lav)	11%	6986
Showers	28%	18,483
Cleaning	2%	1,058
Com. Kitchen food services	10%	6,745
Laundry	5%	3,322
Pool Evaporation	2%	1,300
Pool Backwash	1%	704
Ice Machines	1%	668
RO/Filtration	1%	660
Landscape	4%	2,712
Cooling Tower	12%	7,973
Boiler Make-Up	2%	1,329
Others	1%	664
Total		66,064

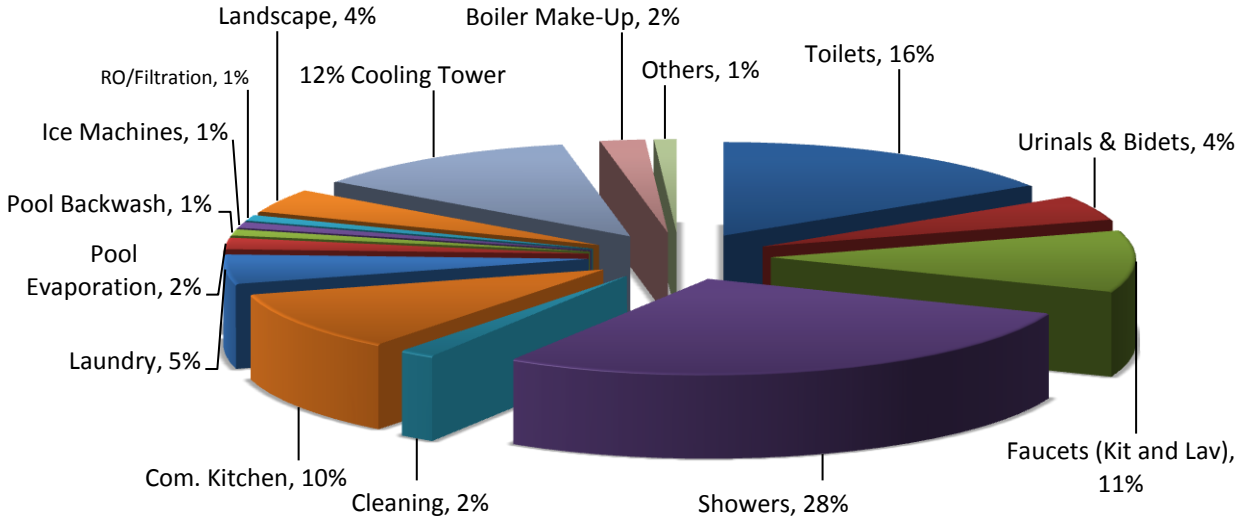

Figure 43: Water use percentages at Hotel 20

Recommended Measures:

Cooling Tower

The hotel had a BAC cooling tower and information on similar size towers from the same manufacturer was utilized to make estimates regarding usage at the hotel. Currently, the towers do not have conductivity controllers that automatically regulate tower blowdown. This leads to unnecessary blowdown; the operator can blow the tower down too often or too long and waste water. A conductivity controller provides a feedback loop that only instructs the tower to

blowdown when dissolved solids in the water begin to affect heat transfer and decrease tower efficiency. It is estimated that approximately 12% of the total use of the hotel is devoted to the cooling tower.

Additionally, the towers have ball float valves that measure tower water levels and prevent overflow. These devices are imprecise, prone to failure, and can lead to tower leakages that can go undetected to untrained staff. These devices should be replaced with electronic float controls that measure water level without moving parts that can become bent, damaged, or break off completely. The hotel should also consider alternative ways to limit cooling tower load, which will in turn limit tower consumption.

Laundry

The hotel has three 120 kg units, and one 40 kg unit. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application. This water can be stored in an existing storage tank and should that tank be used exclusively for rinse water, should not need to be filtered for use in wash cycles. The hotel likely does not wash enough laundry to justify the retrofit cost of a complete laundry reuse system.

Showerheads

Retrofitting these units with pressure compensating, 7.6 lpm maximum units can reduce shower consumption by around 50%.

Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Lavatory & Kitchen Faucets

Faucet flow rates are ridiculously high compared to industry standards and other audit results. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 60% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Swimming Pools

The hotel has an indoor (80m^3) and outdoor (150m^3) swimming pool. The sand filter for the pool does not have an automatic blowdown; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down

Figure 44: Steam room at the hotel

evaporative loss.

Steam Boiler Make-Up

Steam boilers are currently blown down based on the personal judgment of the technician in charge. While "TDS" can be and often is measured by maintenance staff to initiate a blowdown procedure, too often the system is blowndown arbitrarily or as part of a maintenance routine. The hotel should install a conductivity controller to initiate blowdown only when "TDS" levels warrant. Depending on the aggressiveness of the engineers in maintaining the boiler, such a system could save 25-40% of the total water now used as blowdown. The boiler make-up at the hotel was calculated assuming that boiler ran 5 cycles of concentration, used approximately 1,000,000 liters of diesel fuel per year, and recovered 75% of steam condensate.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	10,583
Urinal consumption per year	24
Bidet consumption per year	2,853
Lavatory consumption per year	6,442
Shower consumption per year	18,483
Kitchen faucet consumption per year	544
TOTAL DOMESTIC CONSUMPTION	38,929

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	7,589
Urinal consumption per year	9
Bidet consumption per year	713
Lavatory consumption per year	2,445
Shower consumption per year	8,884
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	20,003

According to the conducted calculations, if the facility implements the recommended domestic measures it will reduce consumption by 18,926 m^3 per year, which is equivalent to an annual saving of 29% of total water use.

Facility 21

Background Information

The Hotel is a five star hotel built in 2006. It has 225 rooms in one building. The total surface area of the building is 39,992 m^2. The hotel has a staff count of 300 employees that work in three shifts 365 days a year.

Water Balance and End Use Types:

The Hotel receives water 24 hours a day, 7 days a week from the Aqaba Water Company. The annual water consumption was estimated at 104,340 m^3. The Hotel's bathrooms contain western-style toilets that flush at 6 lpf. The hotel has 270 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 4 urinals that flush at 3 lpf and 255 bidets that have an average flow rate of 5.2 lpf. The showerhead count is 283 with an average flow rate of 9.6 lpm. There are 311 hand washing lavatory faucets that operate at 7.4 lpm, all are in good condition and are equipped with aerators.

The hotel has a kitchen that produces a daily average of 300 breakfast meals, 100 lunch meals and 150 dinner meals daily. All the meals are served on china plates therefore requiring them to be washed down by three pre rinse nozzles at 7.2 liters per minute (lpm) before being placed in a dishwasher. The kitchen is equipped with one large Hobart dishwasher. The kitchen is also equipped with 2 steam kettles. There are 14 sinks present, each faucet running at 8.2 liters per minute. An additional 5 hand sinks are available for hygiene which run at 4.6 liters per minute. The kitchen floors are hosed down three times daily with a pressure washer at a rate of 4 liters per minute for approximately 12 minutes.

Figure 45 : Swimming pool at the hotel

The hotel uses approximately 50 cubic meters of water each day for its landscape irrigation. Fifty percent of the water used for irrigation is potable, while the other fifty percent is recycled water. During the survey, the audit team was informed that there are plans to install a system that will utilize an estimated 20 cubic meters of pool backwash water for irrigation purposes. There are three swimming pools and one pool of children present at the hotel, all of which are heated. The combined total volume for the pools is 3000 m^3 and the combined total surface area is 2000 m^2. The pools are not covered. They are backwashed daily, which is set by a pressure drop. Make up water is metered. There are two Jacuzzis at the hotel, each with a surface area of 15 square meters. There are also decorative fountains with a combined surface area of approximately 1000 m^2.

The hotel is an air-conditioned facility, and is equipped with two Hoval hot water boilers. The Hotel uses two water softening systems with a resin capacity of 60m^3. These units are regenerated two times a week.

The hotel is equipped with on-site laundry facilities. There two Pellerin Milnor recycle washing machines; one with a 125 Kg capacity that performs 10 loads per day, and one with a 45 Kg capacity that performs 6 loads per day. These machines recycle their rinse water (50% of total

water used per load) back for use in their next wash cycle. There are also two smaller commercial washing machines with capacities of 14 Kg each which perform 5 loads per day, and two smaller guest washing machines with 5Kg capacities and which perform an estimated 3 loads per day. The total water consumed for laundry processes is 6,296 liters each day. The hotel cleans 1,200 m² of its floor surface twice a day using mops and buckets, and cleans an additional 36,000 m² once a day. The results of the end use water balance are illustrated in the Table below.

Table 21: End uses of water at hotel 21

Types	Avg. %	m³/year
Toilets	14%	14,511
Urinals & Bidets	9%	8923
Faucets (Kit and Lav)	14%	14189
Showers	10%	10,582
Cleaning	2%	2,409
Com. Kitchen food services	4%	4,015
Laundry	4%	4,380
Pool/Fountain Evaporation	8%	7,878
Pool Backwash	17%	17,280
Ice Machines	1%	788
RO/Filtration	1%	1,135
Landscape	16%	18,250
Total		**104,340**

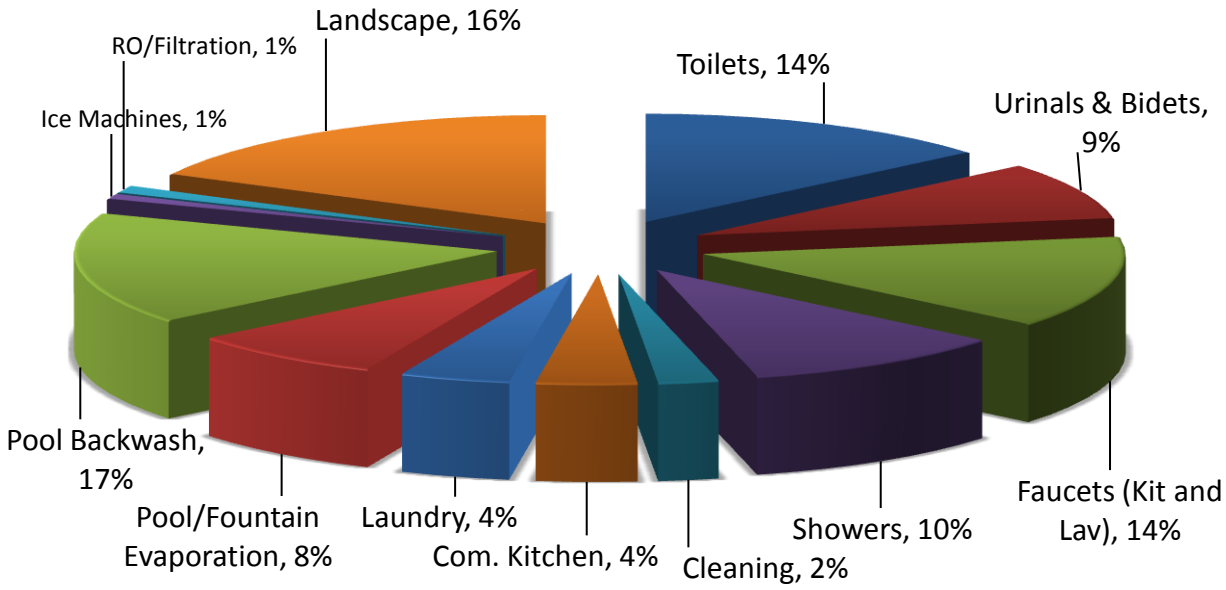

Figure 46: Water use percentages at hotel 21

Proposed Measures:

Toilets

Toilets water consumption at the Hotel seems to be reasonable and within the recommended range, if the hotel considers to further reducing water consumption, it should consider installing dual-flush 3l/6l toilets.

Lavatory Faucets

Faucet flow rates are high compared to the Jordanian standards and other audit results. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 40% of lavatory water use and additional energy costs associated with hot water production and boiler operation.

Showerheads

As discussed above, retrofitting these units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 20%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel's two large commercial washing machines should be retrofitted. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Swimming Pools

The hotel has a large outdoor swimming pool. The sand filter for the pool does not have an automatic blowdown; instead the operator reads a pressure gauge and activates the sequence when he deems it necessary. Having dual pressure gauges on the incoming and outgoing filter lines could make this manual process more efficient, but pressure-based automated regulation should be the ultimate goal. The hotel needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	14,511
Urinal consumption per year	26
Bidet consumption per year	8,897
Lavatory consumption per year	13,112
Shower consumption per year	10,582
Kitchen faucet consumption per year	1,077
TOTAL DOMESTIC CONSUMPTION	48,205

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	9,674
Urinal consumption per year	8
Bidet consumption per year	1,710
Lavatory consumption per year	7,973
Shower consumption per year	8,377
Kitchen faucet consumption per year	1,077
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	28,819

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 19,386 m^3 per year which is equivalent to 19% of total water usage.

Hotel 22

Background Information

The Hotel was built in 2008. It has 201 rooms in three buildings. The total surface area of each building is 37,000 m^2. The hotel has a staff count of 240 employees that work in three shifts 365 days a year. The hotel typically reaches 35% occupancy with roughly 80 guests per day and an average of 15 visitors each day.

Water Balance and End Use Types:

The Hotel receives water 24 hours a day, 7 days a week from Aqaba Water Company. The annual water consumption was estimated at 42,330 m^3.

The Hotel's bathrooms contain western-style, dual-flush toilets that flush at either 9.5 or 4.5 lpf. The hotel has 277 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 2 urinals that flush at 2 lpf and 201 bidets that have an average flow rate of 2.4 lpf. The showerhead count is 205 with an average flow rate of 10.2 lpm. There are 280 hand washing lavatory faucets that operate at 7.2 lpm, all are in good condition and are equipped with aerators.

The hotel has a kitchen that produces a daily average of 180 breakfast meals, 50 lunch meals and 70 dinner meals. All the meals are served on china plates therefore requiring them to be washed down by two pre rinse nozzles at 12 lpm before being placed in either a ware-washer or dishwasher. There are five dish washers (one large and four small units) that each endure a total of 30 loads per day. The kitchen is also equipped with 3 steam kettles that use 50 liters of water three times a day, and 12 other steamer units. There are 5 sinks present, each faucet running at 10.1 liters per minute. An additional 2 hand sinks are available for hygiene which run at 4.5 liters per minute. The kitchens floors—400 m2 of surface area—are hosed down three times daily with a pressure washer at a rate of 5 liters per minute for 1 hour.

The hotel has a sprinkler system to water its turf with a total surface area of 1,000 m2. The turf is in good condition. There are trees and shrubs present on the property. The swimming pool present in this hotel is heated, and has a total volume of 585m3and a surface area of 325 m2. The pool is not covered. It is backwashed daily, which is set by a pressure drop. Make up water is not metered. There are six Jacuzzis with volumes of 1 m3 in rooms, and one large Jacuzzi with a volume of 20 m3. There are also decorative fountains with a combined surface area of 260 m2.

Figure 47:clothes washing machine at the hotel

The hotel is an air-conditioned facility that utilizes 7 air-cooled chilling units. The hotel uses two, one-ton Hoval boilers each with 95% condensate returns, and which require 900 liters of make-up water each day. The condensate receiver uses approximately 20 liters of water per minute to cool incoming condensate—28,800 liters per day which runs to drain. The Kempinski Hotel uses two water softening systems with a resin capacity of 50m^3.

The hotel is equipped with on-site laundry facilities. There are three Electrolux washers (models: W41100H, W4600H, and W414130H); one with a 110 Kg capacity that performs 8 loads per day, one with a 60 Kg capacity that performs 3 loads per day, and one with a 40 Kg capacity that performs 3 loads per day.

The hotel cleans 1,200 m^2 of its floor surface twice a day using mops and buckets, and cleans an additional 36,000 m^2 once a day. The results of the end use water balance are illustrated in the Table below.

Table 22: End uses of water at hotel no. 22

Types	**Avg. %**	**m^3/year**
Toilets	18%	7,770
Urinals & Bidets	2%	797
Faucets (Kit and Lav)	7%	3007
Showers	17%	7,135
Cleaning	6%	2,529
Com. Kitchen food services	5%	2,190
Laundry	4%	1,840
Pool/Fountain Evaporation	4%	1,521
Pool Backwash	5%	2,319
Ice Machines	1%	248
RO/Filtration/Condensate Tempering	25%	10,512
Landscape	4%	1,797
Boiler Make-Up	1%	329
Unaccounted others	1%	336
Total		**42,330**

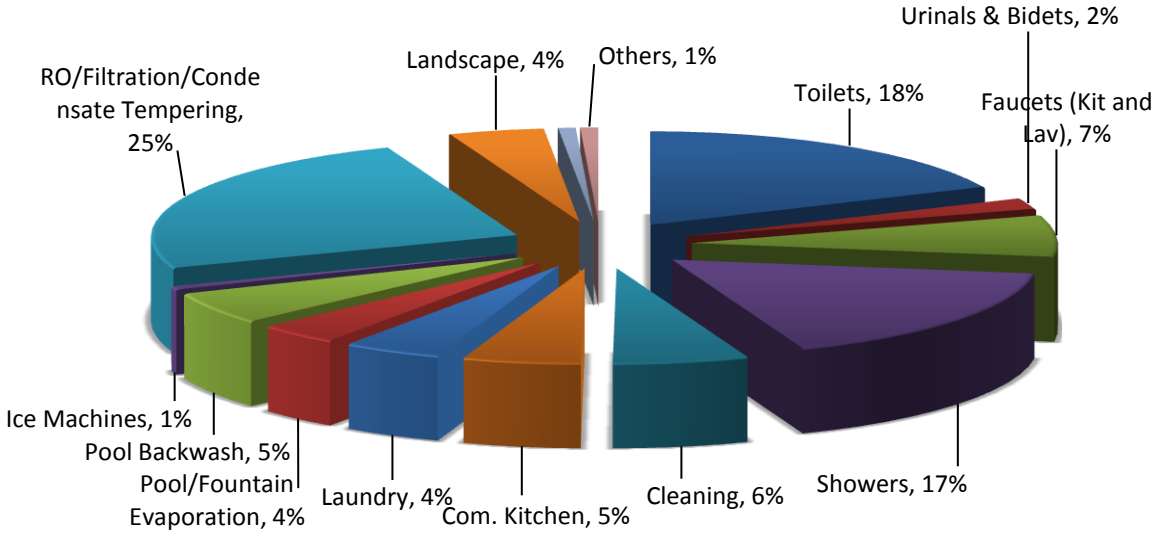

Figure 48: Water use percentages at the facility

Proposed Measures:

Toilets

Toilet tanks should be retrofitted with dual-flush 3l/6l dual-flush toilets.

Lavatory & Kitchen Faucets

Faucet flow rates are ridiculously high compared to industry standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 37% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Showerheads

Retrofitting showerheads with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 25% Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel's three commercial clothes washing machines should be retrofitted. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Irrigation

The hotel should consider the use of water wise landscape best management practices to retrofit all the landscape areas. This would result in tremendous saving of water without losing the attractiveness of the landscape scenery.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	7,770
Urinal consumption per year	2
Bidet consumption per year	795
Lavatory consumption per year	1,680
Shower consumption per year	7,135
Kitchen faucet consumption per year	1,327
TOTAL DOMESTIC CONSUMPTION	18,709

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	3,271
Urinal consumption per year	0.938
Bidet consumption per year	331
Lavatory consumption per year	1,050
Shower consumption per year	5,316
Kitchen faucet consumption per year	1,090
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	11,059

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 7650 m^3 per year which is equivalent to 18% of the total water use.

Hotel 23

Background Information

The Hotel was built in 2006. It has 350 rooms in one building. The total surface area of the building and property is 47,000 m^2. The hotel has a staff count of 305 employees that work 8 hour shifts 365 days a year. The hotel typically reaches 40% occupancy in the spring/summer months with roughly 285 guests per day and an average of 20 visitors each day.

Water Balance and End Use Types:

The hotel receives water 24 hours a day, 7 days a week from the Aqaba Water Company. The annual water consumption was estimated at 96,484 m^3. The Hotel's bathrooms contain western-style toilets that flush at 6.2 lpf. The hotel has 354 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 30 urinals that flush at 2 lpf and 305 bidets that have an average flow rate of 5.2 lpf. The showerhead count is 335 with an average flow rate of 9.2 lpm in addition to 16 beach showers with an average flow rate of 12 lpm. There are 335 lavatory faucets that operate at 4.2 lpm, all equipped with aerators in excellent condition. The hotel has a kitchen that produces a daily average of 300 breakfast meals, 300 lunch meals and 100 dinner meals. All the meals are served on china plates therefore requiring them to be washed down by two pre rinse nozzles at 7.3 liters per minute (lpm) before being placed in the dishwasher. There are two dish washers (one large and one small unit) that endure a total of 100 loads per day, which use a combined 1,760 liters of water per day. There are 12 sinks present, each faucet running at 18 liters per minute. An additional 5 hand sinks are available for hygiene which run at 4.2 liters per minute. The kitchen floors are hosed down three times daily at a rate of 5 liters per minute for 1 hour.

The hotel uses drip and spray landscape irrigation for its newly established landscaping. Because the landscaping is so new, the amount of water used in its upkeep can be reasonably be assumed to be high In addition, non-potable irrigation water is used; 250 m^3 a day which is sub-metered from recycled effluent from Tala Bay Treatment Plant. The grounds recently had sprinkler systems installed. The results of the audit are shown below.

Table 23: End uses of water at facility 23

Types	Avg. %	m^3/year
Toilets	8%	8,166
Urinals & Bidets	4%	3423
Faucets (Kit and Lav)	3%	3264
Showers	16%	15,809
Cleaning	6%	5,532
Com. Kitchen food services	13%	12,775
Laundry	6%	6,242
Pool Evaporation	11%	10,400
Pool Backwash	28%	27,375
Ice Machines	2%	1,664
RO/Filtration	1%	718
Landscape	1%	548
Others	1%	568
Total		**96,484**

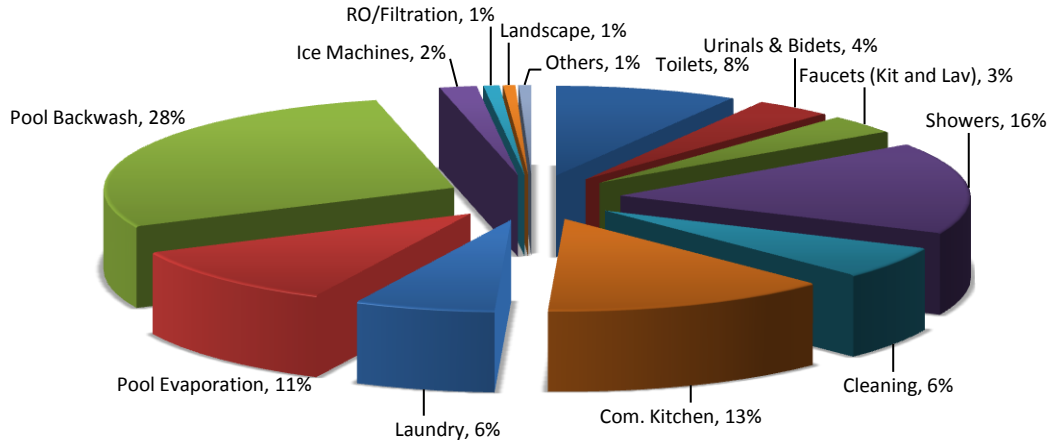

Figure 49: Water use percentages at hotel 23

Proposed Measures:

Toilets

Toilets water consumption at the Hotel seems to be reasonable and within the recommended range, if the hotel considers to further reduce water consumption, it should consider installing dual-flush 3l/6l toilets.

Kitchen Faucets

Appropriate kitchen area faucets should be retrofitted to 8.3 liters per minute

Showerheads

Retrofitting showerhead units with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 17%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Potential Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	8,166
Urinal consumption per year	15
Bidet consumption per year	3,408
Lavatory consumption per year	898
Shower consumption per year	15,809
Kitchen faucet consumption per year	2,366
TOTAL DOMESTIC CONSUMPTION	30,662

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	5,268
Urinal consumption per year	7
Bidet consumption per year	655
Lavatory consumption per year	898
Shower consumption per year	13,059
Kitchen faucet consumption per year	363
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	20,250

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 10,412 m^3 per year which is equivalent to 11% of the total water use.

Facility 24

Background Information

The Hotel is composed of 336 rooms in three buildings (main, south, and north) covering 25,450 m^2. over a total property area of 60,000 m^2. The hotel has a staff count of 305 employees that work 8 hour shifts 365 days a year. The hotel typically reaches 45% occupancy with approximately 275 guests per day and has on average 10 visitors per day.

The hotel receives water 24 hours a day, 7 days a week from the Aqaba Water Company. The annual water consumption was estimated at 52,525 m^3. .

The Hotel's bathrooms contain dual flush toilets that flush at 6.5 lpf. The hotel has 350 toilets that are primarily located in the rooms but also found in the lobby and various parts of the property. This location has 6 urinals that flush at 2lpf and 8 bidets that have an average flow rate of 5lpf. The total showerhead count is 357 with an average flow rate of 8lpm. There are 357 hand washing lavatories that operate at 8lpm. There is one ablution sink with a 7.5 lpm flow rate.

The hotel has a kitchen that produces a daily average of 200 breakfast meals, 50 lunch meals and 90 dinner meals. All the meals are served on china plates, therefore requiring them to be washed down by one pre rinse nozzle at 9.0 lpm before being placed in the dishwasher. The dish washer endures 22 loads per day. There are 6 sinks present, with faucets running at 11.7 liters per minute. An additional three hand sinks are available for hygiene which run at 6 liters per minute. The kitchen floors are hosed down three times daily at a rate of 8 liters per minute for 15 minutes.

Figure 50: Lnadscape of the hotel

The hotel uses drip and spray landscape irrigation for the 15,000 m^2 of turf and 5,000 m^2 of beds. The turf is in good condition and the beds are in fair condition. Evapotranspiration estimates suggest that at least 55 m^3 of water per day would be necessary to properly irrigate the landscape. However for irrigation non-potable irrigation water is used; 100 m^3 a day which is sub-metered of recycled effluent from Tala Bay Treatment Plant. The grounds recently had sprinkler systems installed. During our audit, the hotel had the sprinkler system running mid-day on a windy, 90 degree day. There are four decorative fountains on the grounds that are approximately 6 m^3. They get changed every two weeks which uses approximately 156 m^3 of water annually. The swimming pool present in this hotel is heated with a total volume of 1,000 $m^3$and a surface area of 4,100m^2. The pool is not covered. It is backwashed two times per week at 16 liters per minute for a duration of 12 minutes (using 382 liters per week and 19,968 liters per year) that is set by a pressure drop. 0.5 m^3 of make-up water is added via meter release on a daily basis.

There are two washing machines for use by hotel staff; a new 10 kg capacity machine that washes 12 loads per day and a new 16 kg capacity machine that washes 12 loads per day. Also, for guest use there is an additional new washing machine that has a 5 kg capacity and washes roughly 5 loads per day.

The hotel is an air-conditioned facility using two new 200 ton capacity units. Also, there are 336 room air conditioning units at a 1.5 to 2.0 ton capacity. The hotel uses two hot water boilers. The hotel uses two water softening systems with a resin capacity of 50 m^3, and one regeneration every ten days or 37 times per year. The results of the end use water balance are illustrated in the Table below.

Table 24: End uses of water at facility 24

Types	Avg. %	m^3/year
Toilets	20%	10,653
Urinals & Bidets	3%	1810
Faucets (Kit and Lav)	8%	4365
Showers	15%	8,077
Cleaning	9%	4,624
Com. Kitchen food services	6%	3,103
Laundry	6%	3,011
Pool Evaporation	20%	10,660
Pool Backwash, Decorative Fountains	2%	1,186
Ice Machines	2%	903
RO/Filtration	1%	436
Boiler Make-Up	1%	350
Other	6%	3,347
Total		**52,525**

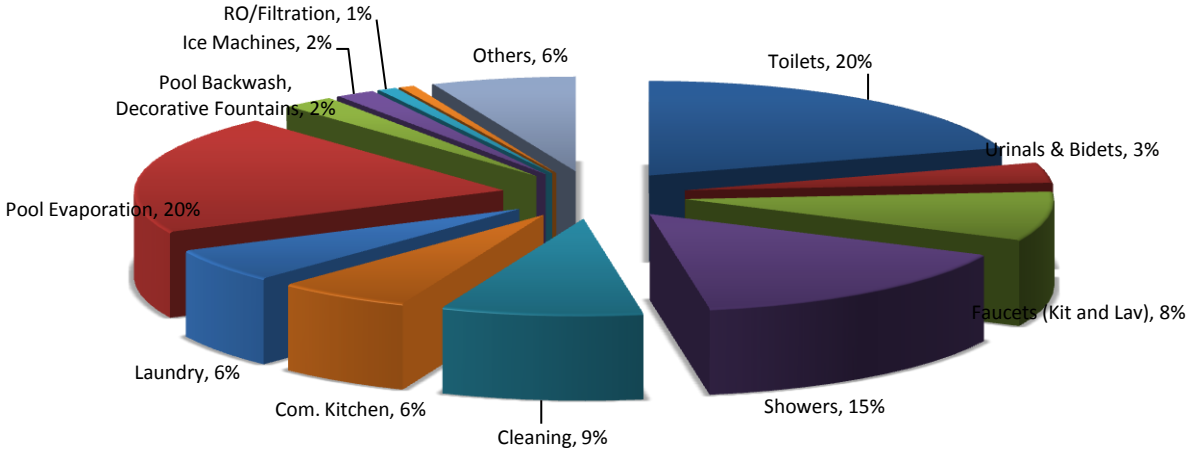

Figure 51: Water use percentages at facility no. 24

Proposed Measures:

Toilets

Toilet tanks should be retrofitted with 6.0 lpf -volume flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The hotel can choose to replace the entire fixture (depending on the designed flush volume of the bowl) or swap out the

adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce water consumption, it should consider installing dual-flush 3l/6l toilets.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to Jordanian standards. By retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could save approximately 44% of lavatory water use and additional energy costs associated with hot water production and boiler operation. Appropriate kitchen area faucets should also be retrofitted to a maximum of 8.3 liters per minute.

Showerheads

Retrofitting showerheads with pressure compensating 7.6 lpm maximum units can reduce shower consumption by 5%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units. This is an inexpensive measure that will save considerable water and energy.

Laundry

The hotel has three commercial clothes washing machines. The hotel can recover nearly 20% of the water used during a cycle by reusing the final rinse as wash water. It will also save energy costs associated with pre-heating that wash water for application.

Potential Domestic Savings:

Building Domestic Subtotals – Consumption m^3/year (Pre Program)	
Toilet consumption per year	10,653
Urinal consumption per year	3
Bidet consumption per year	1,807
Lavatory consumption per year	2,827
Shower consumption per year	8,077
Kitchen faucet consumption per year	1,538
TOTAL DOMESTIC CONSUMPTION	24,905

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	4,954
Urinal consumption per year	1
Bidet consumption per year	361
Lavatory consumption per year	1,590
Shower consumption per year	7,672
Kitchen faucet consumption per year	1,090
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	15,668

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 9237 m^3 per year which is equivalent to 18% of the total water usage.

5.2 Water Use Baseline

The water end-use baseline was determined based on the average percentages of each end use for each category of Hotel facility. Results of the end use baseline for apartment hotels, 2-3 star hotels, 4 star hotels, and 5 star hotels are presented hereafter.

Apartment Hotels

The baseline water use for apartment hotels is shown in the following pie chart. The chart indicates that all the water supplied to apartment hotels is used for indoor purposes. The most important uses are Toilets (35%), Showers (25%), and Faucets (24%). Urinals& Bidets and cleaning use respectively, 11% and 3% of the total water use. The audited data also revealed that the average water consumption in liters per guest per day for apartment hotels is 234.

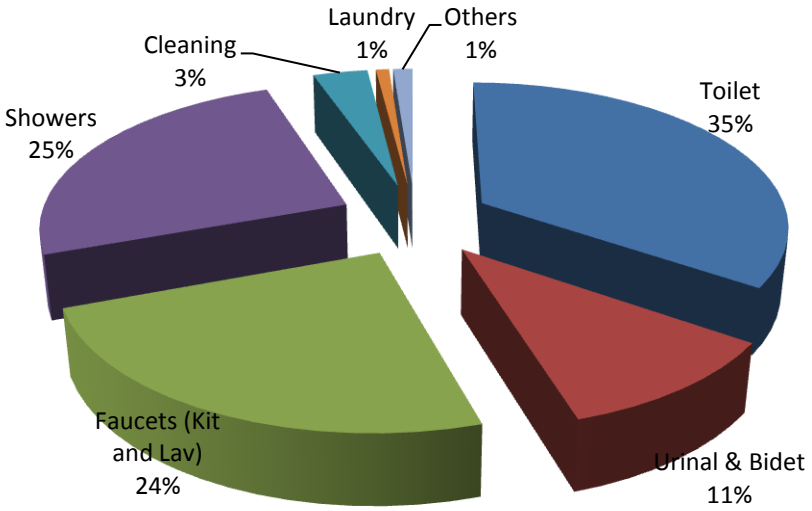

Figure 52: Water use baseline for apartment hotels

2-3 Star Hotels

The baseline water use for 2-3 star hotels is shown in the following pie chart. The chart indicates that the majority of the water supplied is used for indoor purposes (97%). The most important uses are Toilets (33%), Showers (26%), and Faucets (12%). Urinals& Bidets, commercial kitchen, laundry, and cleaning use respectively, 8%, 8%, 6%, and 3% of the total water use. Outdoor water use (3%) is exclusively reserved to swimming pools and water features. The audited data also revealed that the average water consumption in liters per guest per day for 2-3 star hotels is 160.

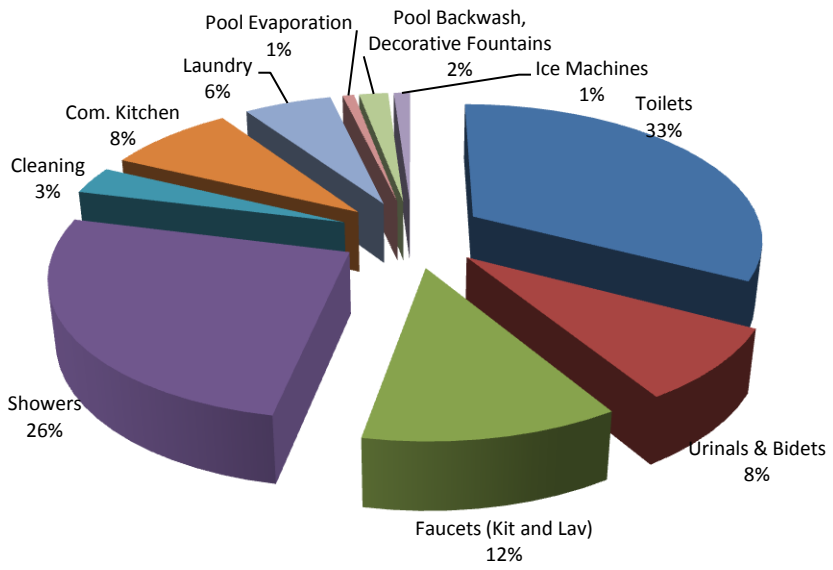

Figure 53: Water use baseline for 2-3 star hotels

Four Star Hotels

The baseline water use for 4 star hotels, audited in Amman and Aqaba, is shown in the pie chart below. The chart indicates that the majority of the water supplied to four star hotels is used for indoor purposes (90%). The most important uses are Showers (24%), Toilets (21%), commercial kitchen (11%), and Faucets (10%). Laundry, Urinals& Bidets, and cleaning use respectively, 8%, 5%, and 4% of the total water use. Outdoor water use (10%) is mainly used in swimming pools and landscape. The audited data also showed that the average water consumption in liters per guest per day for 4 star hotels is 349.

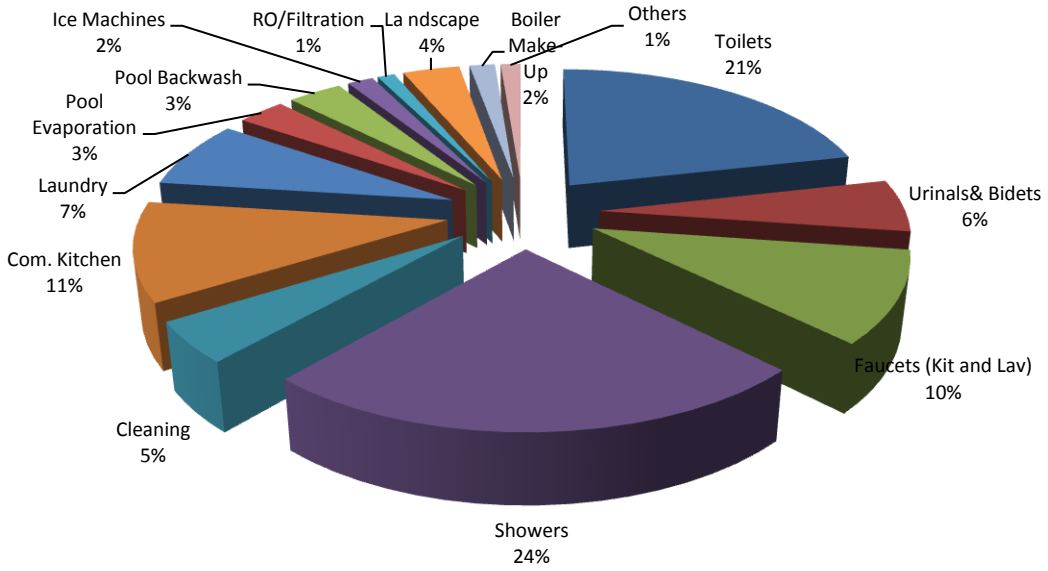

Figure 54: water use baseline for four star hotels

Five Star Hotels

The baseline water use for 5 star hotels, audited in Amman and Aqaba, is shown in the following pie chart. The chart indicates that around 78% of the water supplied to apartment hotels is used for indoor purposes. The most important indoor uses are Showers (24%), Toilets (14%), commercial kitchen (8%), and Faucets (8%), and Laundry (7%). Urinals& Bidets and cleaning use respectively, 5% and 4% of the total water use. Outdoor water use (22%) is used in swimming pools (18%) and landscape (4%). The audited data also showed that the average water consumption in liters per guest per day for 4 star hotels is 873.

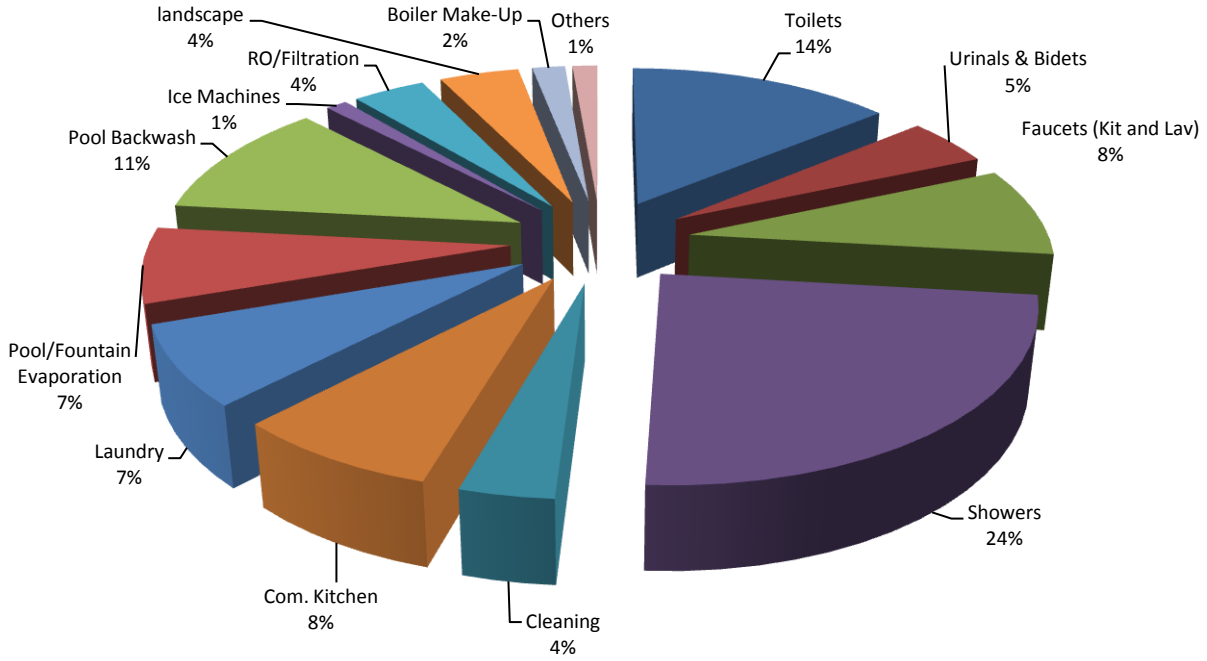

Figure 55: Five star hotels baseline water use

5.3 Cost effectiveness calculations

Cost effectiveness was conducted for the audited facilities based on the potential savings resulting from the adoption of the recommended measures, and the cost of water and wastewater based on the commercial tariff (JD 1.56 /m^3). Water tanker cost was estimated at JD2.18/ m^3 in addition to JD0.56/ m^3 for sewage treatment. The interest rate used for the calculation is 7% and the present value of the water saved was calculated based on the initial cost and the life time of the fixture. Cost of energy, which is embedded in the cost of water, was estimated at around JD 4.25/m^3.

The savings (JD/Year) was calculated as follows = Number of uses per day (for example, number of flushes per day) x amount of saving per use (m^3) x number of days facility occupied per year x cost of water per m^3.

Cost of Retrofit = Number of fixtures at the facility x Cost of replacing existing fixture.

Cost effectiveness calculations for retrofit of toilets and faucets for the audited hotels, which have water saving potential, are presented in Tables 29-32. The cost of the fixture and its installation was estimated at JD150, JD25, and JD4 for toilet, toilet trim, and faucet aerator; respectively. The life time is 20 years for the toilet and 5 years for the faucet aerator and toilet trim. The toilet trim replacement is given as an option for users in case the toilet replacement is not cost-effective. Cost analysis for fixtures without installation, assuming that it is done by the facility staff, is also presented.

Results of the main plumbing fixtures retrofit for apartment hotels, 2-3 star hotels, 4 star hotels, and 5 star hotels are presented hereafter.

1. Apartment Hotels

Table 25 indicates that faucets and showerheads retrofit by installing flow regulators (aeartor) is highly feasible with a payback period of around 16 days for showerheads at facility 3, and varying between 13 days for faucets in facility 5 and around a year and three months for faucets in facility 2. Toilet trim replacement is generally cost effective with a payback period varying between 1.2 month for facility 5 and 2.5 years for facility 4. Toilet replacement is only feasible for facilties 5 and 3.

Table 25: Cost effectiveness calculations for Apartment Hotels

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility 1	Toilet (3l/6l)	27	4	ave. liters per flush	8.9	204	365	20	100	2,700	150	4,050	1,006	367	0%	1.56	573	11,453	56.58	84.87
	Toilet Trim	27	4	ave. liters per flush	8.9	204	365	5	20	540	25	675	1,006	367	0%	1.56	573	2,863	11.32	14.14
	Total for All Equipment									3,240		4,725						14,316		
Facility 2	Toilet (3l/6l)	48	4	ave. liters per flush	7.4	390	365	20	100	4,800	150	7,200	1,312	479	0%	1.56	747	14,945	77.08	115.62
	Toilet Trim	48	4	ave. liters per flush	7.4	390	365	5	20	960	25	1,200	1,312	479	0%	1.56	747	3,736	15.42	19.27
	Faucet Aerators	48	4.5	lpm	5.8	62	365	5	0.5	24	2.5	120	83	30	30%	2.84	86	430	3.35	16.75
	Total for All Equipment									5,784		8,520						19,111		
Facility 3	Toilet (3l/6l)	5	4	ave. liters per flush	8.3	125	365	20	100	500	150	750	538	196	0%	1.56	306	6,121	19.60	29.41
	Toilet Trim	5	4	ave. liters per flush	8.3	125	365	5	20	100	25	125	538	196	0%	1.56	306	1,530	3.92	4.90
	Faucet Aerators	6	4.5	lpm	7.8	12	365	5	0.5	3	2.5	15	40	14	30%	2.84	41	205	0.88	4.39
	Shower heads	7	7.6	lpm	10.0	120	365	5	0.5	4	2.5	18	288	105	50%	3.69	387	1,937	0.11	0.54
	Total for All Equipment									607		908						9,793		
Facility 4	Toilet (3l/6l)	35	4	ave. liters per flush	7.0	207	365	20	100	3,500	150	5,250	621	227	0%	1.56	354	7,072	118.78	178.17
	Toilet Trim	35	4	ave. liters per flush	7.0	207	365	5	20	700	25	875	621	227	0%	1.56	354	1,768	23.76	29.69
	Faucet Aerators	65	4.5	lpm	8.4	40	365	5	0.5	33	2.5	163	156	57	30%	2.84	161	807	2.42	12.08
	Total for All Equipment									4,233		6,288						9,647		
Facility 5	Toilet (3l/6l)	5	4	ave. liters per flush	10	358	365	20	100	500	150	750	2145	783	0	2	1221	24427	5	7
	Toilet Trim	5	4	ave. liters per flush	10.0	358	365	5	20	100	25	125	2,145	783	0%	1.56	1,221	6,107	0.98	1.23
	Faucet Aerators	6	4.5	lpm	10.7	66	365	5	0.5	3	2.5	15	409	149	30%	2.84	423	2,117	0.09	0.43
	Total for All Equipment									603		890						32,651		

2. 2-3 Star hotels

Table 26 indicates that faucets and showerheads retrofit by installing flow regulators (aeartor) is generally feasible with a payback period of around one and a half month for showerheads at facility 9, and varying between 8 months for faucets in facility 9 and around four years for faucets in facility 6. Toilet trim replacement is less cost effective with a payback period varying between 2.5 years for facility 6 and around 3 years for facility 8. Toilet replacement is not cost effective.

Table 26: Cost effectiveness calculations for (2-3) star hotels

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility no. 6	Toilet (3l/6l)	112	4	ave. liters per flush	9.0	384	365	20	100	11,200	150	16,800	1,920	701	0%	1.56	1,093	21,865	122.9	184.4
	Toilet Trim	112	4	ave. liters per flush	9.0	384	365	5	20	2,240	25	2,800	1,920	701	0%	1.56	1,093	5,466	24.6	30.7
	Faucet Aerators	112	4.5	lpm	5.5	62	365	5	0.5	56	2.5	280	62	23	30%	2.84	64	321	10.5	52.4
	Total for All Equipment									13,496		19,880						27,652		
Facility no. 7	Toilet (3l/6l)	142	4	ave. liters per flush	6.7	724	365	20	100	14,200	150	21,300	1,921	701	0%	1.56	1,094	21,882	155.7	233.6
	Toilet Trim	142	4	ave. liters per flush	6.7	724	365	5	20	2,840	25	3,550	1,921	701	0%	1.56	1,094	5,470	31.1	38.9
	Faucet Aerators	142	4.5	lpm	8.4	69	365	5	0.5	71	2.5	355	266	97	30%	2.84	275	1,374	3.1	15.5
	Total for All Equipment									17,111		25,205						28,727		
Facility no. 8	Toilet (3l/6l)	127	4	ave. liters per flush	6.2	729	365	20	100	12,700	150	19,050	1,633	596	0%	1.56	930	18,596	163.9	245.9
	Toilet Trim	127	4	ave. liters per flush	6.2	729	365	5	20	2,540	25	3,175	1,633	596	0%	1.56	930	4,649	32.8	41.0
	Faucet Aerators	117	4.5	lpm	7.0	104	365	5	0.5	59	2.5	293	260	95	30%	2.84	269	1,345	2.6	13.0
	Total for All Equipment									15,299		22,518						24,590		
Facility no. 9	Toilet (3l/6l)	101	4	ave. liters per flush	5.4	822	365	20	100	10,100	150	15,150	1,170	427	0%	1.56	666	13,321	182.0	273.0
	Toilet Trim	101	4	ave. liters per flush	5.4	822	365	5	20	2,020	25	2,525	1,170	427	0%	1.56	666	3,330	36.4	45.5
	Faucet Aerators	105	4.5	lpm	9.2	78	365	5	0.5	53	2.5	263	367	134	30%	2.84	379	1,897	1.7	8.3
	Shower heads	101	7.6	lpm	12.0	354	365	5	0.5	51	2.5	253	1,558	569	50%	3.69	2,095	10,475	0.29	1.45
	Total for All Equipment									12,173		17,938						18,548		

3. Four Star hotels

Table 27 indicates that showerheads retrofit by installing flow regulators (aeartor) is higly feasible with a payback period varying between one month for facility 13 and 5 months for facility 15. Faucets retrofit is generally feasible with a paybasck period ranging from 3 months for facilty 10 and five months for facilty 15. Toilet trims replacement is less cost effective with a payback period varying between 1.2 years for facility 12 and around 5.4 years for facility 15. Toilet replacement is generally not cost effective.

Table 27: Cost effectiveness calculations for four star hotels

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility 10	Toilet (3l/6l)	200	4	ave. liters per flush	7.4	1681	365	20	100	20,000	150	30,000	5,783	2,111	0%	1.56	3,293	65,853	72.9	109.3
	Toilet Trim	200	4	ave. liters per flush	7.4	1681	365	5	20	4,000	25	5,000	5,783	2,111	0%	1.56	3,293	16,463	14.6	18.2
	Faucet Aerators	200	4.5	lpm	8.7	481	365	5	0.5	100	2.5	500	2,013	735	30%	2.84	2,083	10,417	0.6	2.9
	Shower heads	200	7.6	lpm	8.2	2208.0	365	5	0.5	100	2.5	500	1386.18	506	50%	3.69	1,864	9,322	0.6	3.2
	Total for All Equipment									24,100		35,500						92,732		
Facility 11	Toilet (3l/6l)	192	4	ave. liters per flush	6.0	2112	365	20	100	19,200	150	28,800	4,292	1,566	0%	1.56	2,444	48,873	94.3	141.4
	Toilet Trim	192	4	ave. liters per flush	6.0	2112	365	5	20	3,840	25	4,800	4,292	1,566	0%	1.56	2,444	12,218	18.9	23.6
	Faucet Aerators	192	4.5	lpm	5.7	606	365	5	0.5	96	2.5	480	727	265	30%	2.84	752	3,762	1.5	7.7
	Total for All Equipment									23,136		34,080						64,853		
Facility 12	Toilet (3l/6l)	225	4	ave. liters per flush	8.3	1849	365	20	100	22,500	150	33,750	7,949	2,901	0%	1.56	4,526	90,518	59.7	89.5
	Toilet Trim	225	4	ave. liters per flush	8.3	1849	365	5	20	4,500	25	5,625	7,949	2,901	0%	1.56	4,526	22,630	11.9	14.9
	Faucet Aerators	231	4.5	lpm	5.2	299	365	5	0.5	116	2.5	578	209	76	30%	2.84	217	1,083	6.4	32.0
	Total for All Equipment									27,116		39,953						114,231		
Facility 13	Toilet (3l/6l)	126	4	ave. liters per flush	6.0	1570	365	20	100	12,600	150	18,900	3,140	1,146	0%	1.56	1,788	35,758	84.6	126.9
	Toilet Trim	126	4	ave. liters per flush	6.0	1570	365	5	20	2,520	25	3,150	3,140	1,146	0%	1.56	1,788	8,940	16.9	21.1
	Shower heads	110	7.6	lpm	10.4	826	365	5	0.5	55	2.5	275	2,311	844	50%	3.69	3,109	15,544	0.2	1.1
	Total for All Equipment									15,175		22,325						60,242		
Facility 14	Faucet Aerators	99	4.5	lpm	7.9	217	365	5	0.5	50	2.5	248	737.8	269	30%	2.84	763	3,817	0.8	3.9
	Shower heads	83	7.6	lpm	12.8	405	365	5	0.5	42	2.5	208	2106	769	50%	3.69	2,833	14,163	0.2	0.9
	Total for All Equipment									91		455						17,980		
Facility 15	Toilet (3l/6l)	280	4	ave. liters per flush	5.7	2024	239	20	100	28,000	150	42,000	3,441	822	0%	1.56	1,283	25,657	261.9	392.9
	Toilet Trim	280	4	ave. liters per flush	5.7	2024	239	5	20	5,600	25	7,000	3,441	822	0%	1.56	1,283	6,414	52.4	65.5
	Faucet Aerators	301	4.5	lpm	7.8	339	239	5	0.5	151	2.5	753	1,119	267	30%	2.84	758	3,790	2.4	11.9
	Shower heads	265	7.6	lpm	8.7	1733	239	5	0.5	133	2.5	663	1,906	456	50%	3.69	1,679	8,395	0.9	4.7
	Total for All Equipment									33,883		50,415						44,256		

4. Five Star hotels

Table 28 indicates that showerheads retrofit by installing flow regulators (aeartor) is higly feasible with a payback period varying between 8 days for facility 20 and 5 months for facility 24. Faucets retrofit is also highly feasible with a paybasck period ranging from 1.7 months for facilty 17 to 3 months for facilty 24 . Toilet trims replacement is generally cost effective for selected facilities . Toilet replacement is generally not cost effective

Table 28: Cost effectiveness calculations for five star hotels

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility 16	Toilet (3l/6l)	270	4	ave. liters per flush	5.2	3280	365	20	100	27,000	150	40,500	3,936	1437	0%	1.56	2,241	44,823	144.57	216.85
	Toilet Trim	270	4	ave. liters per flush	5.2	3280	365	5	20	5,400	25	6,750	3,936	1437	0%	1.56	2,241	11,206	28.91	36.14
	Faucet Aerators	330	4.5	lpm	10.8	1563	365	5	0.5	165	2.5	825	9,847	3594	30%	2.84	10,189	50,947	0.19	0.97
	Shower heads	283	7.6	lpm	11.4	3065	365	5	0.5	142	2.5	708	11,647	4251	50%	3.69	15,666	78,328	0.11	0.54
	Total for All Equipment									32,707		48,783						185,303		
Facility 17	Toilet (3l/6l)	277	4	ave. liters per flush	6.8	3990	365	20	100	27,700	150	41,550	10,996	4,014	0%	1.56	6,261	125,227.46	53.09	79.63
	Toilet Trim	277	4	ave. liters per flush	6.8	3990	365	5	20	5,540	25	6,925	10,996	4,014	0%	1.56	6,261	31,307	10.62	13.27
	Faucet Aerators	287	4.5	lpm	16.7	1143	365	5	0.5	144	2.5	718	13,999	5,110	30%	2.84	14,486	72,431	0.12	0.59
	Shower heads	205	7.6	lpm	15.2	11136	365	5	0.5	103	2.5	513	84,807	30,955	50%	3.69	114,068	570,340	0.01	0.05
	Total for All Equipment									33,486		49,705						799,306		
Facility 18	Toilet (3l/6l)	354	4	ave. liters per flush	7.2	3164	365	20	100	35,400	150	53,100	10,147	3,704	0%	1.56	5,778	115,553	73.52	110.29
	Toilet Trim	354	4	ave. liters per flush	7.2	3164	365	5	20	7,080	25	8,850	10,147	3,704	0%	1.56	5,778	28,888	14.70	18.38
	Faucet Aerators	354	4.5	lpm	11.2	904	365	5	0.5	177	2.5	885	6,021	2,198	30%	2.84	6,230	31,150	0.34	1.70
	Shower heads	351	7.6	lpm	13.3	4416	365	5	0.5	176	2.5	878	25,008	9,128	50%	3.69	33,636	168,181	0.06	0.31
	Total for All Equipment									35,400		53,100						115,553.44		
Facility 19	Toilet (3l/6l)	354	4	ave. liters per flush	8.4	4574	365	20	100	35,400	150	53,100	20,249	7,391	0%	1.56	11,530	230,597	36.84	55.27
	Toilet Trim	354	4	ave. liters per flush	8.4	4574	365	5	20	7,080	25	8,850	20,249	7,391	0%	1.56	11,530	57,649	7.37	9.21
	Faucet Aerators	352	4.5	lpm	7.6	2167	365	5	0.5	176	2.5	880	6,653	2,428	30%	2.84	6,884	34,420	0.31	1.53
	Shower heads	351	7.6	lpm	9.7	6744	365	5	0.5	176	2.5	878	14,214	5,188	50%	3.69	19,118	95,589	0.11	0.55
	Total for All Equipment									42,832		63,708						418,255		
Facility 20	Toilet (3l/6l)	541	4	ave. liters per flush	5.6	5248	365	20	100	54,100	150	81,150	8,203	2,994	0%	1.56	4,671	93,411	139.00	208.50
	Toilet Trim	541	4	ave. liters per flush	5.6	5248	365	5	20	10,820	25	13,525	8,203	2,994	0%	1.56	4,671	23,353	27.80	34.75
	Faucet Aerators	541	4.5	lpm	11.8	1503	365	5	0.5	271	2.5	1,353	10,949	3,997	30%	2.84	11,330	56,651	0.29	1.43
	Shower heads	289	7.6	lpm	12.6	5224	365	5	0.5	145	2.5	723	26,298	9,599	50%	3.69	35,371	176,855	0.05	0.25
	Total for All Equipment									65,335		96,750						350,270		
Facility 21	Toilet (3l/6l)	304	4	ave. liters per flush	6.0	6626	365	20	100	30,400	150	45,600	13,252	4,837	0%	1.56	7,546	150,914	48.35	72.52
	Toilet Trim	304	4	ave. liters per flush	6.0	6626	365	5	20	6,080	25	7,600	13,252	4,837	0%	1.56	7,546	37,728	9.67	12.09
	Faucet Aerators	280	4.5	lpm	7.4	4855	365	5	0.5	140	2.5	700	14,080	5,139	30%	2.84	14,569	72,846	0.12	0.58
	Shower heads	266	7.6	lpm	9.6	3024	365	5	0.5	133	2.5	665	6,048	2,208	50%	3.69	8,135	40,674	0.20	0.98
	Total for All Equipment									36,753		54,565						302,161		
Facility 22	Toilet (3l/6l)	439	4	ave. liters per flush	9.5	2241	365	20	100	43,900	150	65,850	12,326	4,499	0%	1.56	7,018	140,363	75.06	112.59
	Toilet Trim	439	4	ave. liters per flush	9.5	2241	365	5	20	8,780	25	10,975	12,326	4,499	0%	1.56	7,018	35,091	15.01	18.77
	Faucet Aerators	436	4.5	lpm	7.2	639	365	5	0.5	218	2.5	1,090	1,725	630	30%	2.84	1,785	8,926	1.47	7.33
	Shower heads	500	7.6	lpm	10.2	1916	365	5	0.5	250	2.5	1,250	4,982	1,818	70%	4.54	8,246	41,230	0.36	1.82
	Total for All Equipment									53,148		79,165						225,610		
Facility 23	Toilet (3l/6l)	345	4	ave. liters per flush	6.2	3610	365	20	100	34,500	150	51,750	7,942	2,899	0%	1.56	4,522	90,443	91.55	137.32
	Toilet Trim	345	4	ave. liters per flush	6.2	3610	365	5	20	6,900	25	8,625	7,942	2,899	0%	1.56	4,522	22,611	18.31	22.89
	Shower heads	266	7.6	lpm	9.2	4709	365	5	0.5	133	2.5	665	7,534	2,750	50%	3.69	10,134	50,670	0.16	0.79
	Total for All Equipment									41,533		61,040						163,724		
Facility 24	Toilet (3l/6l)	318	4	ave. liters per flush	8.6	3394	365	20	100	31,800	150	47,700	15,612	5,699	0%	1.56	8,890	177,794	42.93	64.39
	Toilet Trim	318	4	ave. liters per flush	8.6	3394	365	5	20	6,360	25	7,950	15,612	5,699	0%	1.56	8,890	44,449	8.59	10.73
	Faucet Aerators	318	4.5	lpm	8.0	968	365	5	0.5	159	2.5	795	3,388	1,237	30%	2.84	3,506	17,529	0.54	2.72
	Shower heads	268	7.6	lpm	8.0	2768	365	5	0.5	134	2.5	670	1107.2	404	50%	3.69	1,489	7,446	1.08	5.40
	Total for All Equipment									38,453		57,115						247,218		

6. Conclusions:

Following are the main conclusions of the end use report for the Hotels sector in Jordan:

1. Around 78% of water use at 5 star hotels occurs indoor. Most of the indoor use takes place at Showers (24%), followed by Toilets (14%), Swimming pools (18%), Faucets (8%), Commercial Kitchen (8%), and Laundry (7%). Urinals and Bidets (5%), Cleaning (4%), Landscape (4%), Ro Filtration (4%), Boiler make up(2%), Ice machines (1%) account for 20% of the indoor use. Outdoor use (22%) is reserved to swimming pools (18%) and landscape (4%).
2. Around 90% of the water use at 4 star hotels is indoor. Major indoor users include Showers (24%), Toilets (21%), Commercial Kitchen (11%), Faucets (10%), and Laundry (7%). Urinals and Bidets (6%), Cleaning (5%), Boiler make up (2%), Ice machines (2%), and Ro Filtration (1%) use 16% of the total water consumption. Outdoor use (10%) is split between swimming pools (6%) and landscape (4%).
3. Only 3% of the water use at 2-3 star hotels is supplied outdoor for swimming pool purposes. The rest of the water (97%) is consumed indoor. The major indoor water users include Toilets (33%), Showers (26%), Faucets (12%), Commercial Kitchen (8%), Urinals and Bidets (8%), and Laundry (6%).
4. All the water use at apartment hotels is indoor for Toilets (36%), Showers (27%), Faucets (22%), Urinals and Bidets (11%), and Cleaning (4%).
5. The average water consumption in liters per guest per day is 873 for five star hotels, 349 for four star hotels, 160 for 2-3star hotels, and 234 for apartment hotels .
6. Retrofitting faucets and showerheads in all Hotels is generally proven to be highly cost effective.
7. Replacement of toilet trims is generally cost effective. However, toilet replacement is in most cases not cost effective.
8. All the audited categories of hotels have a sizable potential for water saving. It varies between 16%-49% for apartment hotels, 22%-29% for 2-3 star hotels, 11%-23% for 4 star hotels, and 11%-33% for 5 star hotels.
9. Landscape irrigation is highly inefficient in the hotels that have irrigated landscape. Most of the irrigation is done manually with a hose resulting in a considerable wastage of water.
10. Potential water saving at swimming pools can be reached by improving backwashing practices and reducing evaporation.

7. General Recommendations

1. Install pressure compensating and tamper proof water flow regulators for faucets with flows exceeding 4.5 lpm.

2. Retrofit showerheads by installing pressure compensating flow regulators for showers exceeding a flow rate of 7.6 lpm.

3. Retrofitting toilets is only recommended when economically feasible. Toilets should be retrofitted with 6lpf toilets or dual flush toilets (3l/6l) that dispense an average of 4 lpf.

4. Replace toilet trims/flashing devises, if economically feasible. Wherever possible, it is recommended that staff begin reducing toilet consumption by recalibrating toilet tank float valves to deliver a maximum of 6.0 liters per flush.
5. Replace 1:3 RO systems with RO systems that have 1:1 product to reject ratio

6. Use backwashing and evaporation reduction best practices to improve water use efficiency in swimming pools.
7. Provide regular maintenance and repair for all plumbing fixtures including toilet flushing valves and faucets, and leak detection via dye testing.
8. In the case of large landscape areas, it is recommended to use non-conventional water resources for irrigation, such as rainwater harvested from roof top, gray water, and treated waste water. High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

9. Conduct awareness programs targeting staff, guests, and visitors to increase their knowledge of how to use water more efficiently.
10. Conduct regular water audits to identify areas of water saving, and develop and implement water efficiency programs.

11. Appendix
Hotel's Audit Form

Audit Survey Form

Date: _____ **التاريخ:** Auditor: _____ **المحقق/ المدقق:**

Name of facility:_____ **إسم المنشأ:**

Operational Company Name:_____ **إسم الشركة التشغيلية**

Address: _____ **العنوان:**

Manager name: _____ **إسم مدير المنشأ** Telephone: _____ **الهاتف**

FAX: _____ **الفاكس**

e-mail address: _____ **البريد الإلكتروني**

Date facility built: _____ **تاريخ بناء المنشأ**

<u>Census and occupancy data based on daily averages for year (answer where applicable):</u>

Number of buildings the hotel is composed of_____عدد المباني التي يتكون منها الفندق

Total area of each building:_____المساحة الإجمالية لكل مبنى

Number of staff :_____عدد الموظفين; % Male _____نسبة الذكور

Number of rooms: _____عدد الغرف

Occupancy rate for hotels and apartments: _____نسبة إشغال الفندق والشقق الفندقية

Average number visitors per day: _____ متوسط عدد الزائرين في اليوم

Number of days per year operational: _____ عدد أيام الإشغال سنوياً

Number of hotel rooms rented per day_____ عدد الغرف التي يتم إشغالها يومياً

يرجى الحصول على المخططات التالية:

1. **التمديدات الصحية ومخططات الطوابق المختلفة**

Engineering drawings (Plumbing drawings and floor plans)

2. **مخططات المساحة الخارجية المزروعة**

Irrigation drawings (irrigation engineering drawings, if available, otherwise site maps including general landscaping information

ACTIVITY AND EQUIPMENT CHECKLIST (check or fill in all that are applicable)

Main Kitchen Operations **عمليات المطبخ الرئيسية**

عَدِّد (أدرج) الوجبات المقدمة في اليوم الفطور _____ الغداء_____ العشاء_____ غير ذلك _____

No. of meals/day served Breakfast: ___, Lunch: ___ Dinner: ____ Other: _____

عَدِّد (أدرج) الوجبات المقدمة في الصحون _____ عَدِّد (أدرج) الوجبات المقدمة في الصحون[1] القابلة للإتلاف_____

Number of meals served on china_____ Number served on disposable ware_____

FOOD SERVICE ITEMS **بنود خدمات الطعام**

Water cooled refrigeration equipment **معدات التبريد التي تعمل بإستخدام المياه المبردة**

Water cooled ice makers **معدات صنع الثلج التي تعمل بإستخدام المياه المبردة**

Air cooled ice makers (Including remote head units) **معدات صنع الثلج التي تعمل بإستخدام الهواء المبرد (وتشمل وحدة التحكم عن بعد)**

Freezers **الفريزرات**

Steam tables **طاولات بخار**

_____

[1] صحون إستعمال مرة واحدة

Boilerless Steamer	مبخرة بدون مرجل لتوليد البخار
Boiler type Steamer	مولدات بخار بإستخدام المراجل
Combination ovens	الأفران التجميعية
Steam kettles	غلايات البخار
Garbage grinders (disposers)	مطاحن القمامة (والتخلص منها)
Dish Washer/Ware-washer	غسالات أطباق
Three compartment sinks	مجلى بثلاثة مصارف
Pot soaker	مجلى لنقع الطناجر
Pulper	مستأصل اللب
Sluice trough to garbage grinder (disposal)	حوض صغير لطحن القمامة
Pre-rinse spray with shutoff	رشاش ما قبل الشطف مع قاطع للتيار الكهربائي أتوماتيكي
Confectionary faucet – (ice cream scoop sink & faucet)	صنبور حلويات – (صنبور و حوض للمثلجات)
Faucets drip	حنفيات تنقيط
Thaw meat in sink	إذابة اللحوم المجمدة في أحواض الجلي
Water left running	الصب المتواصل للمياه
Kitchen floors hosed down at end of day	ترك خرطوم المياه على أرضية المطبخ عند الشطف
Other	غيرها

_____

WATER TREATMENT	معالجة المياه
Water Softener	جهاز تنقية المياه من الشوائب
Reverse Osmosis	جهاز تنقية المياه من الأملاح باستخدام التناضح العكسي
Water Stills	أجهزة تقطير المياه
Ultra-pure Water System	نظام للتنقية القصوى للمياه
Other	غيرها

_____

LABORATORY EQUIPMENT أدوات المختبر

Vacuum autoclaves without water tempering device

Vacuum autoclaves with water tempering device

Gravity autoclaves without water tempering device

Gravity autoclaves with water tempering device

Air cooled compressors (no water use)

Water cooled and sealed air compressors

MECHANICAL EQUIPMENT المعدات الميكانيكية

Air conditioned facility – tons _____ **مكيفات الهواء – السعة بالطن**

Cooling towers – tons_____ **أبراج تبريد –السعة بالطن**

Contract for cooling water treatment **إتفاقية لمعالجة المياه المستخدمة في التبريد**

Contract specifies cycles of concentration for cooling tower **إتفاقية تحدد دوائر التركيز لبرج التبريد**

أنظمة التبريد والتدفئة بإستخدام وحدة تبريد وتدفئة مركزي مغلقة

Closed loop chilled/hot water system for heating and cooling

جمع وإعادة استخدام مبردات الهواء بأبراج التبريد لأغراض الري

Collect and reuse air conditioner condensate for irrigation of cooling towers

أبراج تحتوي على عداد لقياس كميات المياه المضخوخة لبرج التبريد بهدف تعويض الفاقد

Towers equipped with a make-up meter

Towers equipped with bleed off or blowdown meters

Towers equipped with conductivity controllers

RESTROOM ROOMS الحمامات

Number of toilets _____ عدد المراحيض

التدفق (لتر بالدفقة) (إختر واحدة مما يلي) 6 13.25 13.25أعلى من

Litters per flush (circle one) 6.0 lpf 13.25 lpf Over 13.25 lpf

Number of urinals _____ عدد المبولات

Litters per flush (circle one) 3.8 lpf 7.6 lpf Over 7.6 lpf لتر بالدفقة (إختر واحدة مما يلي)

Number of showers ____ عدد الدوشات

Shower flow rate _____ lpm معدل تدفق الدوش _____ لتر/ دقيقة

Number of hand washing lavatories عدد المغاسل (لغسل اليدين)

Flow rate of aerators _____ lpm معدل تدفق أجهزة الإشباع بالهواء (لتر/ دقيقة)

Other water using fixtures or appliances أي تركيبات أو قطع أخرى تستخدم للمياه

_____

LOCKER ROOMS

Number of toilets _____ عدد المراحيض

Litters per flush (circle one) 6.0 lpf 13.25 lpf Over 13.25 lpf لتر بالفورة (إختر واحدة مما يلي)

Number of urinals _____ عدد المبولات

Litters per flush (circle one) 3.8 lpf 7.6 lpf Over 7.6 lpf لتر بالفورة (إختر واحدة مما يلي)

Number of showers ____ عدد الدوشات

Shower flow rate _____ lpm معدل تدفق الدوش _____ لتر/ دقيقة

Number of hand washing lavatories عدد المغاسل (لغسل اليدين)

Flow rate of aerators _____ lpm معدل تدفق أجهزة الإشباع بالهواء (لتر/ دقيقة)

Clothes washer غسالات الملابس

Hot tub or Jacuzzi أحواض ساخنة أو جاكوزي

Other water using fixtures or appliances أي تركيبات أو قطع أخرى تستخدم للمياه

_____

LANDSCAPE **المساحات الخارجية**

Landscape irrigation **ري الحدائق(غير المساحات المخصصة للرياضة)**

جدول الري – عدد المرات بالأسبوع _____ عددالدقائق لكل منطقة _____

Irrigation schedule – use per week _____ minutes per zone _____

مساحة المرج (متر مربع):_____مساحة الأحواض (مثل أحواض الزهور) - متر مربع _____

Square meters of turf: _____ Square meters of beds: _____

Type of turf: _____ **نوع المرج**

Installed sprinkler system (Yes) (No) **نظام ري بالرشاشات؟ (نعم) (لا)**

Managed by landscape company (Yes) (No) **تديرهُ شركة مختصة؟ (نعم) (لا)**

Condition of irrigation system :_____**وضع نظام الري**

Type of plant material: _____**نوع النباتات المزروعة**

Soil depth: _____ عمق التربة

Opportunity for rainwater harvesting: _____ **هل هناك فرصة لتخزين مياه الأمطار**

هل هناك إستخدام للمياه غير الصالحة للشرب لري المزروعات_____

Opportunity for non-potable sources of irrigation water _____

_____

SWIMMING POOLS, THERAPY POOLS AND SPAS برك سباحة، برك علاج، ومنتجعات إسترخاء علاجية

Water meter on make-up **هل يوجد عداد لقياس المياه المفقودة من البركة**

Total volume _____**الحجم الكلي**, Surface area:_____**مساحة السطح**

Heated pool; temperature_____**درجة حرارة البرك المدفأة**

ما هي ميكانيكية سحب المياه من البركة لتنظيف الفلاتر؟ هل يتم تفعيلها عند إنخفاض الضغط أي بدون استخدام المؤقت؟

Backwash set by pressure drop and not timer _____

هل يتم إعادة استخدام هذه المياه لري المزروعات_____

Backwash water reused for irrigation_____

هل يتم تغطية البرك الساخنة عندما لا تكون مستخدمة منعاً للتبخر_____

Hot tubs covered when not in use to prevent evaporation _____

DECORATIVE FOUNTAINS AND WATER FEATURES ديكورات النوافير ومعالم مائية اخرى مع التصوير

Describe decorative fountains _____ **وصف موجز للنوافير إن وجدت**

Describe ponds, streams, etc. _____ **وصف للجداول ، برك تجمع المياه وما الى ذلك...**

Describe other features _____ **وصف المعالم الاخرى**

المصارف الخارجية و التنظيف (مواقف سيارات، مباني، مناطق القمامة والنفايات، وما الى ذلك)

OUTSIDE WASHDOWN AND CLEANING (parking lot, building, dumpster area, etc.)

Pressure washer used (Yes) (No) **هل يتم استخدام آلة غسيل تعمل بالضغط (نعم) (لا)**

Garden hose used (Yes) (No) **هل يتم استخدام خرطوم مياه حديقة (نعم) (لا)**

إذا كان الجواب على البند السابق نعم، هل الخرطوم معد بفوهة إغلاق (nozzles) (نعم) (لا))

Shut-off nozzles on hose, if hose used (Yes) (No)

هل يمكن استبدال أعمال التنظيف الخارجية التي تستخدم المياه بأدوات التكنبس أو النفخ (للاوراق مثلاً) (نعم) (لا)

Can sweeping & blowing substitute for outdoor cleaning? (Yes) (No)

هل يوجد لديكم معدات لغسل السيارات أو المركبات (نعم) (لا)

Car or vehicle washing equipment? (Yes) (No)

Other outdoor uses: _____ غيرها من الاستخدامات الخارجية

LAUNDRY FACILITIES منشآت الغسيل

Number washers available for use _____ عددالغسالات المتوفرة للاستعمال

Number of loads washed per month _____ ما هو عدد الأحمال في الشهر

On Premise Commercial Laundry Equipment هل يتم استخدام معدات غسيل لأغراض تجارية في الموقع

Capacity (Kilo) for each _____ القدرة الاستيعابية للغسالة (كيلو)

عدد الأحمال للملابس ذات الأوساخ الخفيفة لكل يوم _____

Number of loads per day for lightly soiled items _____

عدد الاحمال ذات الأوساخ الثقيلة لكل يوم _____

Number of loads per day for heavily soiled items _____

يوجد إعادة تدوير للمياه أو هل يتم استخدام معدات للمعالجة بالأوزون (نعم) (لا)

Water recycle or ozone equipment used (yes) (No)

CLEANING AND OTHER INDOOR USES التنظيف والإستخدامات الداخلية الأخرى

نظافة الخزائن التي يحتفظ فيها بمواد وأدوات التنظيف ووضع أحواض الغسيل من حيث النظافة _____ _____

Janitorial closet or sink condition:_____ _____

مصدر المياه الخاصة بالمسح_____ إستخدام الخرطوم العادي عدد المرات التي يتم فيها المسح في اليوم _____ للشطف _____

Moping/Day: ____ Source of mop water:_____ Hose down: _____

إذا كان الخرطوم هو المستعمل ، هل يوجد عليه فوهة رشاش (نعم) (لا) وما هو مقدار التدفق_____ لتر/ دقيقة

Does hose have spray nozzle (yes) (no) – what is flow rate _____ litter per minute

هل هو من النوع الذي يستخدم أنبوب معقم مائي (نعم) (لا)

Floor cleaning machine (wet vacuum type) (yes) (no)

Water broom (yes) (no) **هل يوجد مكنسة تستخدم المياه (نعم) (لا)**

TOTAL WATER USAGE

Total Metered Water Use:

Main Meter Units (thousands of liters, cubic meters, etc.) _____

وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ)_____

Amount for last year: **الكمية للسنة الماضية**

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**

October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

Water purchased from private sources **المياه التي تم شراؤها من مصادر خاصة**

Main Meter Units (thousands of liters, cubic meters, etc.) _____

_____وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ)

Amount for last year: **الكمية للسنة**
الماضية

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**
October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

Other water sources **مصادر المياه الأخرى**

ain Meter Units (thousands of liters, cubic meters, etc.) _____

_____وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ)

Amount for last year: **الكمية للسنة**
الماضية

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**
October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

List Sources: _____عدد المصادر